BANGALORE WATER SUPPLY AND SEWERAGE BOARD

5th Floor, Cauvery Bhavan "D" Block,
K.G. Road, Bangalore 560009

Tender for the : Work Of Providing And Laying 900/1200/1400mm Dia RCC NP-3 Class Sewer Line Including Trenchless Technology Method From M V Garden To Amarjyothi Layout ISPS Domluru

(Through Karnataka Procurement Portal only)

https://www.kppp.karnataka.gov.in

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VOLUME II

SECTION 7

TECHNICAL SPECIFICATIONS

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PART 1

PROJECT INFORMATION

PART 1

PROJECT INFORMATION

1.1 BWSSB C Valley Division

The flow from ward 89, 90 and 112 is at present flowing in the existing sewer network, however due to insufficient carrying capacity of the sewers, the sewers either overflows on the road or in the adjacent drain. Thus a gravity sewer of diameter 900, 1200 and 1400mm RCC NP3 pipe from Gurudwara near Ulsoor till the office of AEE, BWSSB, Amar Jyoti layout is proposed.

1.2 Location and Description of the Works

1.2.1 Location of the Works

The Works considered are as follows;

S.No.	Work Name	Proposed ϕ (mm)	Proposed Length (m)
1	Work of Providing and Laying 900/1200/1400mm Dia RCC NP-3 Class Sewer Line Including Trenchless Technology Method from M V Garden to Amarjyothi Layout ISPS Domluru	900	835
2		1200	1276
3		1400	2387

The detailed location is shown on the Drawing.

1.2.2 Description of the Works

The Works shall comprise of construction for Providing and Laying 900/1200/1400mm Dia RCC NP-3 Class Sewer Line in Challaghatta Valley.

The Works under this contract shall include but not be limited to the following:

- Civil works of trunk sewer of about 4.5 km with the diameter range 900/1200/1400mm in Challaghatta Valley Area
- Miscellaneous civil works, for site development works such as river crossing bridge, site grading, trenchless work, road works, pavement, temporary works required for all the alignment above.

1.3 Funding Agency

Funds for the contract are being provided by the Government of Karnataka and BWSSB

1.4 Additional Scope

In addition to the above, the following services are included in the scope of the Contract:

(a) Supply of specified mandatory spare parts, wherever applicable.

(b) Supply of specified standard and special tools.

(c) Furnishing of drawings, documents, operation and maintenance manual.

It is not the intent to specify completely herein all details pertaining to design, shop testing, installation, field testing and commissioning. However, these shall conform in all respects to high standards of engineering design, workmanship, meeting the requirements of all applicable codes and standards including local statutory requirements. The Employer shall have power to reject any work or material which in his judgement is not in full accordance therewith.

1.5 General Information

1.5.1 Civil

The following site conditions shall generally apply:

Maximum Temperature	36° C
Minimum Temperature	11° C
Maximum Relative Humidity	75%
Minimum Relative Humidity	28%
Altitude	As per respective drawings
Average Annual Rainfall	844 mm
Seismic Zone	Zone as per IS 1893
Approach Road	City Railway Station
Nearest Airport	KIAL, Bangalore
Nearest Railway station for:	City Railway Station, Bangalore

1.5.2Electrical

Not Applicable

1.6 Geo-technical Information

Geotechnical investigation report for the three sites is available at BWSSB’s office. The Board accepts no responsibility, whatsoever for inferences drawn from this data and the Contractor is deemed to have satisfied on his own responsibility as to the extent to which this information represents the conditions to be encountered.

End of Part 1

PART - 2

THE SITE

PART - 2

THE SITE

2.1 Location of the work

The location of the works is as indicated below: and details of site location are shown on drawings.

Sl no	Work Details
1	Work of Providing and Laying 900/1200/1400mm Dia RCC NP-3 Class Sewer Line Including Trenchless Technology Method from M V Garden to Amarjyothi Layout ISPS Domluru.

2.2 Access to the Site

The main access to the proposed site is Domluru main road and Outer Ring Road.

2.3 Areas Outside the Site

In the event of the Contractor making use of any special or temporary wayleave or accommodation acquired by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such wayleave, accommodation or tip is situated and shall make a record agreed by the owner, occupier or authority as aforesaid of the condition of the surface of that land before entering thereon.

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer access for the purposes of the Contract to any such special or temporary wayleave or additional accommodation.

In the event of the Contractor making use of any special or temporary wayleave or additional accommodation made available to him by the Employer for the purpose of the Contract, the land in which such wayleave or accommodation is situated shall be deemed to be part of the site.

The Contractor shall restrict his activities to within the working area to be approved by the Engineer after the Contractor submits the proposal for the same. On completion of the works in this area, the Contractor shall reinstate the area to its original condition to the satisfaction of the Engineer.

For the purposes of this Clause, `accommodation' shall be deemed to include housing, offices, workshops, warehouses, and storage areas.

2.4 Road Works

The Contractor shall obtain the Engineer’s permission for carrying out works such as excavation on the existing roads. The Contractor shall be responsible for establishing and maintaining temporary road diversions for the duration of the road works. The road shall be kept open at all times during the road works period and the work shall be carried out in such a manner as to minimize the disruption to execution of other Contractor’s works.

2.5 Maintenance of Existing Access Roads

The Contractor shall only use existing access roads within the Site boundary which are necessary for the execution of the Works. The Contractor shall obtain the Engineer's approval in writing before utilizing existing access roads within the Site. Once the Engineer's approval has been given the Contractor shall be solely responsible for the maintenance of the existing site access roads. This responsibility shall continue until the completion of the Defects Liability Period, or until such earlier date as the Engineer may advise the Contractor in writing. Such maintenance work shall include general up-keeping and any necessary repairs to damaged road surfaces, pavement, drainage, associated slopes, etc to a standard, no worse than the original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer's and his staff's vehicles and also those of other contractors over these access roads, which may comprise temporary diversions, all to the approval and satisfaction of the Engineer.

The Contractor shall not run tracked or unsprung vehicles on surfaced roads without the written approval of the Engineer who may require that planking or some other protective material be used to protect the road surface.

The contractor shall provide Liquid waste handling vehicles, fire and rescue vehicles, and allied equipment like Vacuum Pumps, Multi- pressure pumps, Portable as well as vehicle mounted fire/dewatering pumps, and Split shaft Power take-off (PTO) units

2.6 Clearance of the Site

The Contractor shall clear the Site to the extent required by the Engineer for checking the setting-out.

Clearance of the Site shall also include the demolition and removal of all articles, objects, trees, shrubs and obstructions which are expressly required to be cleared.

The Contractor shall ensure that the parts of the Site to be occupied by the Permanent Works are clear and shall maintain the remainder of the Site as may be required for access and Temporary Works areas.

The Contractor shall remove the material arising from such clearance and dispose it off in a manner and at a location, on or off the Site, to the approval of the Engineer.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil which result from clearing the parts of the Site not subsequently to be occupied by the Works.

The Contractor shall not clear the Site of any structure without the prior written permission of the Engineer.

2.7 Clearance and Reinstatement of the Site on Completion

On completion of the Works, the Contractor shall clear any temporary works areas and temporary access roads and reinstate the areas to their original condition and to the satisfaction of the Engineer.

2.8 Site Records

The Contractor shall make records of the position and extent in the excavations of every type of service, stratum and obstruction encountered during the construction of the Works.

2.9 Access for the Employer and Engineer

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer including workmen of the Employer, other contractors or utility undertakings access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary wayleave for the duration of the Contract period.

2.10 Permission from Service Agencies

The Contractor, who is the sole responsible to get the necessary permission from service agencies, such as, BBMP, BDA, Traffic Police, KPTCL, etc. the delay in getting the permission will not be taken into account. The contractor shall obtain the Engineer's permission for carrying out the works such as, excavation on the existing roads, Employer will assist contractor to issuing the letter to the concerned department, if necessary.

2.11 Water Supply at Site and Wastewater Disposal

Water supply for the purposes of constructing the works and testing of the pipe alignment shall be arranged by the Contractor at his own cost.

Wastewater shall be disposed off clear of the Site to the satisfaction of the Engineer so as to cause no damage or complaint.

2.12 Sanitary and Washing Facilities

Throughout the period of construction of the Works the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing

facilities for use by his employees. He shall ensure that his employees do not foul the Site but make proper use of the latrines.

Where practicable the latrines shall be connected to the nearest sewer, or if this is not practicable the Contractor shall provide an adequately sized septic tank and soakpit.

The Contractor is also to provide separate latrines to the above requirements for all the Engineer's staff.

After Completion the latrines and washing facilities shall be removed, all ground disinfected and the surface reinstated to the satisfaction of the Engineer.

2.13 Electricity for Contractor's Use on Site

The Contractor shall be responsible for the provision and distribution of an electrical supply for the purpose of constructing the Works.

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take every possible precaution to ensure that his installation is safe and injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety aspects.

The Contractor shall test the temporary site distribution system every 3 months for compliance with the relevant standards.

2.14 Works in the vicinity of Electrical Equipment

Any permanent fencing or other safeguards required to be erected around electrical equipment shall be completed as far as practicable before connection is made to the electricity supply. Where this is not practicable, the Engineer may permit the use of temporary fencing or other safeguards.

2.15 Refuse Disposal on Site

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in tidy condition to the satisfaction of the Engineer.

2.16 Noise

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

2.17 Warning and Safety Signs

During construction of the Works statutory safety signs, shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points.

Provision of signs, and the positions of signs shall be subject to the Engineers approval. Special attention shall be given to areas designated hazardous. (as per IS-8989)

2.18 Site Working Hours

The proposed Site working hours shall be notified by the Contractor for Engineer's approval. The Contractor shall not vary or increase the working hours without the prior approval of the Engineer.

2.19 Contract Signboards

The Contractor shall supply and erect signboards at his own cost at locations to be specified by the Engineer. The layout and dimensions of the signboards and their construction shall be to the approval of the Engineer and the lettering in both Kannada and English shall be black on a white background.

2.20 Advertising

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Engineer.

2.21 Protection of Trees

Trees designated by the Engineer shall be protected from damage during the course of the work and earth level within one meter of each such tree shall not be changed. Where necessary, such trees shall be protected with temporary fencing. All such cost shall be borne by the Contractor.

End of Part 2

PART - 3

ENGINEER'S REQUIREMENTS

PART 3

ENGINEER'S REQUIREMENTS

3.1 Office

A separate Engineer's office for the sole use of the Engineer and his staff shall be provided by the Contractor for this contract at location identified by BWSSB. The Contractor shall provide, erect, furnish, clean, maintain and subsequently remove the office after the completion of works at the instruction of the Engineer. The proposed office building shall meet the following minimum carpet area requirements:

(a) Engineering Room - 2 Nos., 10m x 8m each with attached toilet
(b) Engineering Room - 1 No., 5m x 5m
(c) Computer Room with Air Conditioner 1 No. 3m x 3m
(d) Toilets with wash basin - 1 Nos. 1.5m x 2m each

The walls shall be of 230 thick brick masonry, plastered and with oil bound distemper on the inner face and snowcem on the outer face. AC sheet roofing with 6 mm thick hard board false ceiling at 3 meter from floor, painted with oil bound distemper shall be provided. The doors shall be of first quality wood and steel windows of approved quality shall be provided. The flooring for the office building shall be minimum 2.5 mm thick Vinyl flooring over PCC base. Before commencing the construction of the office, the Contractor shall submit to the Engineer for his approval a drawing of the proposed building with all architectural and finishing details fully shown. The location of the office shall be as directed by the Engineer.

The Engineer's office should be ready in all respects within 60 days of handing over the site. The Office shall be maintained throughout the contract period and defect liability period there on with office boy, power, water and housekeeping. Power and water supply shall be arranged by the Contractor either with the available resources or from independent sources (like DG sets, borewells, etc.) at his own cost.

The Contractor shall furnish the rooms as the Engineer directs and the equipment, furniture, furnishings and fittings to be supplied shall be of approved make and include the following at each site.

(a) 10 Nos. of 5' x 3' table with both side drawers (3 on each side)
(b) 2 No. of 3' x 2' table with single side three drawers
(c) 20 chairs (approved make) excluding chairs for Computer and Conference
(d) 3 Nos. of Steel cupboards (Storewel type)
(e) 2 Nos. - 4 Drawers Filing Cabinet

(f) Curtains to all windows
(m) Computer Table and Chair
(n) Brand new personal computer and Laptop with following features including UPS of 500 VA:

- Pre-loaded with licensed **I5 processor with quad core**
- ATX Cabinet
- 512 KB external cache
- 4 GB RAM
- 500 GB HDD
- COMBO DRIVE – R/ CD/R/W
- 48X speed CD-ROM on EIDE controller
- 17” SVGA LCD color monitor
- 8 USB 2 serial ports + 1 parallel port
- Internet key board
- Optical Mouse and Mouse pad
- Security and Management features
- HP Laser jet Printer (Suitable for A3 size paper) or equivalent
- Additional software – with licensed windows 10 OS, antivirus, antispyware Autocad latest version and firewall
- HP Business inkjet 2800
- All the necessary consumables, including paper, CDs, printer cartridges etc

The fittings shall include:

(a) 2 Nos of 4' – 0" long tube lights in each room except in Conference room and toilet.
(b) 2 Nos. of normal pendant bulbs of 100 watts in all rooms
(c) 1 Nos. 48" ceiling fan in each room
(d) All rooms with 2 plug points each

These items are to be maintained in proper condition throughout the construction period and shall be removed after completion of the job, as directed by the Engineer.

No separate payment shall be made for items covered above including Engineer's office with the exception of running cost of cellular phone for which a separate provisional sum is allotted.

3.2 Assistance to the Engineer

The Contractor shall provide all necessary assistance to the Engineer and his staff in carrying out their duties of checking, inspecting and measuring the Works. The Contractor shall provide chainmen, staff men, office attendants and labourers as may be needed from time to time by the Engineer at his own cost.

The Contractor shall provide for the Engineer and his staff, consultants and their staff and visitors such protective clothing, safety helmets and rubber boots of suitable sizes, hand lamps and the like as may be reasonably required by them. These articles shall remain the property of the Contractor. No separate payment shall be made on this account.

3.3 Instruments to be provided

The Contractor shall provide at his own cost for the exclusive use of the staff of the Engineer all survey equipments and measuring instruments of approved make and of every kind necessary for the execution of the Works, including

One 360 degrees circle optic theodolite, to read to one second, complete with carrying case and sliding leg tripod, all to the approval of the Engineer ;Two automatic surveyor’s levels with horizontal 360 degrees circle, tripod with carrying case, all to the approval of the Engineer;

Two staffs, 4.5 m long, each in 3 sections and with attached bubbles, graduated in metres and tenth and hundredths of a meter, all to the approval of the Engineer ;

Two Surveyor’s steel bands of which one shall be 100 m long and approximately 20 mm wide and one shall be at least 30 m long and approximately 12 mm wide, each fully divided, complete with tape thermometers and tension handles and wound on an open plastic cross, all to the approval of the Engineer ;

An adequate number of ranging rods, steel and linen tapes, string lines, pegs, lines, spirit levels, survey umbrellas, lights, batteries, stores and tools.

The instruments mentioned above shall be for exclusive use of the Engineer and shall remain in the custody of the Engineer till the Works are completed.

The Contractor shall be solely responsible for all such instruments and equipments and shall ensure that they are at all times in good repair and adjustment, and shall make good any loss or damage howsoever caused. No separate payment shall be made on this account.

On completion of the Works, the entire set of instruments provided by the Contractor shall be returned back to him.

3.4 Telephone

The Contractor shall arrange for a telephone line with internet facility at each site as directed by Engineer for his sole use. The Contractor shall pay for their installation charges. A separate provisional sum is allotted for the payment of calls made by the Engineer.

3.5 Transport

The Contractor shall provide one new top end Mahindra Scorpio version fully loaded to be kept available at all times for the sole use of the Engineer and his staff. At the end of project (after completion of Defect Liability period) the contractor shall handover the vehicle in good condition to Employer.

The Contractor shall be solely responsible for the running and upkeep for the transport including taxes, insurance, licenses, fuel, oils, lubricants, repairs and maintenance and shall also provide a competent driver with the vehicle up to the end of Defect liability period. No separate payment shall be made for providing above.

End of Part 3

PART 4

GENERAL REQUIREMENTS

PART 4

GENERAL REQUIREMENTS

4.1 Standard Specifications

Except where otherwise specified the works under this contract shall comply with the requirements of the referenced Indian Standards (IS), British Standards (BS), AWWA standards, ISO standards, AWS standards, ASTM standards, etc. Other equivalent national or international Standard Specifications such as those issued by the Japanese Industrial Standards (JIS) or similar other organizations may be considered at the sole discretion of the Employer's Representative or as may have been agreed in the contract. All standards used shall be the current version.

The Contractor shall obtain at least one copy of each IS, JIS, BS or other approved standards or reference material which are referred to in the Specification and a copy of all other standards which apply to materials which are being supplied to, or workmanship executed on the works. These standards and reference material shall be supplied to the Employer's Representative within 90 days of the Employer's Representative's order to commence the works and will be available to the Contractor at all reasonable times.

All materials and workmanship not fully specified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area.

Where the requirements of any such standard specification or regulation conflict with Employer's Requirements, then the Contractor should refer to the Employer's Representative for clarification before proceeding with that section of the works.

4.2 Tender Drawings and Contract Documents

A list of the Tender Drawings is given in Volume 4 of this tender document. These drawings are made for tenderer's guidance only. "Released for Construction" drawings will be issued to the Contractor during the progress of work. "Released for Construction" drawings may be revised and revised copies will be issued to the Contractor during the execution of the Works. "Released for Construction" drawings will progressively be issued during the construction, broadly conforming to the basic scheme indicated in the tender drawings.

No claim will be entertained on the score that the details shown on "Released for Construction" drawings are different from those shown on the tender drawings, unless the drawings indicate such items of work which are not a part of the Bill of Quantities.

The Contractor shall be furnished, free of charge, two certified true copies of the Contract Documents and all further drawings which may be issued during the progress of work as aforesaid. He shall keep one copy of these documents on the Site in good order and the same shall at all reasonable times be available for inspection and use by the Engineer, his representative, or other inspecting officers.

one of these documents shall be used by the Contractor for any purpose other than that of the Contract.

The documents and drawings issued as above remain the property of the Board and shall be returned to the Engineer not later than the end of the Defects Liability Period.

4.3 Programme of Works

The Works to be carried out under this Contract form an important part of the construction and satisfactory progress of the scheme as a whole will depend on timely completion of these works. For this reason great importance is placed on proper programming of the civil works with adequate provision for guarding against all the delays normally encountered in construction work. The time for completion of this Contract is specified in Appendix to Tender (Volume 3).

No extension of time will be granted by the Engineer in respect of inclement weather or its effects (such as floods or droughts), fire or industrial disputes, unless such events could not reasonably have been foreseen by an experienced Contractor. All allowances to guard against such delays shall be clearly indicated in his programme.

Upon the award of Contract and 28 days before starting work on the site, the Contractor shall submit for the Engineer’s approval a detailed Programme of Works in the form of a PERT/CPM Network and a bar chart together with description of his proposed method of working in soft copy also. The programme of the other contracts which are having interface with the present contract will be supplied to the Contractor prior to the commencement of works for proper planning and coordination with other contractors.

4.4 Progress

The Contractor shall regularly review his programme in the light of the progress actually achieved and shall submit for approval, updated PERT/CPM Network and bar charts at three months interval. If the progress fails behind that needed to ensure timely achievement of specified milestones, the Contractor shall submit proposals for improving his methods and pace of working to the satisfaction of the Engineer and shall carry out such measures which are needed to ensure that the Works are completed on time.

4.5 Meetings

From time to time the Engineer will call meetings in his office or at the Contractor's office, or at the Site, as he deems necessary, to discuss progress and any technical points requiring settlement. The Contractor's Representative or responsible representative shall attend such meetings.

The Contractor shall prepare and submit to the Engineer a daily activity report summarizing the main activities undertaken each day.

4.6 Photographs

The Contractor shall supply negatives, soft copy of photographs and unmounted positive colour prints not less than 250 x 200 mm of such portions of the Works, in progress and completed, as may be directed by the Engineer and specified herein. The negatives and prints shall not be retouched. The negative of each photograph shall be the property of the Employer and shall be delivered to the Engineer with the prints. No prints of these negatives shall be supplied to any other person without the written permission of the Engineer.

The photographs shall be of two categories:

- progress photographs (quarterly basis)
- record photographs.

Both categories of photographs shall be properly referenced to the approval of the Engineer, and on the back of each print shall be recorded the date and time of the photograph, the direction in which the camera was facing, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be supplied with three prints, having the reverse of one subscribed with the signatures and seal of the Contractor and the Engineer (or their authorized representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

The Contractor shall supply one negative and three prints of each progress photograph ordered by the Engineer. The Contractor shall supply two additional prints of progress photographs selected by the Engineer for incorporation in albums. The Contractor shall supply two sets of albums, mount the prints, and title the prints and albums all to the approval of the Engineer. No separate payment will be made for the photograph submission as indicated above.

Taking of photographs of the Works by the Contractor for any other purpose whether for use in India or in any other country shall not be carried out without written approval from the Engineer.

4.7 Site Labour and Supervision

The Contractor shall provide all the skilled and unskilled labour required, and all necessary tools and equipments for execution of the Works within the period agreed in the programme.

The Contractor shall not remove any supervisory staff or skilled labour from the Site without the Engineer's prior approval.

4.8 Sub-letting

The Contractor shall not sub-let the whole of the Works. Where any part of the Works is sublet, the Contractor shall not be relieved of his obligation under the Contract. The Contractor shall be responsible for the acts, defaults and neglect acts in the Works of any sub-contractor, as if they were his own.

Where the Engineer/Employer has consented to sub-contractors proposed by the Contractor, such manufacturers or sub-contractors shall not be changed without the prior approval in writing of the Engineer. Upon the completion of the work, the work will be acknowledged by the Engineer/Employer based on the request.

A copy of every sub-order shall be sent to the Engineer/Employer at the time the order is placed each clearly marked with the title of the Contract and the Contract number.

4.9 Languages

All drawings, instructions, signs, notices, name-plates, etc. for use in the Works shall be in English.

All site sign boards and warning signs shall be in Kannada and English.

4.10 Notice of Operations

The Contractor shall give full and complete written notice of all important operations to the Engineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

4.11 Protection of Existing Installations

The Contractor shall apply to the Engineer in writing at least 28 days before starting any work that involves interference with existing structures, equipment, etc. The Contractor shall not execute such work until he has received permission to proceed in writing from the Engineer. The Contractor shall ensure that no earth, debris or rock is deposited on public or private roads or rights of way as a result of the Works and all vehicles leaving the Site shall be cleaned accordingly.

4.12 Fencing, watching and lighting

The Contractor shall provide and maintain at his own expense all lights, guards, fencing and watching when and where necessary or as required by the Engineer for the safety and conveniences of those employed on the works or the public.

4.13 Protection of Existing Public and Private Services

The Contractor shall notify all public authorities, utility companies and private owners of proposed works that will affect them not less than two weeks before commencing the works.

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners or the Engineer as appropriate.

If any damage to services results from the execution of the Works, the Contractor shall immediately:

(a) Notify the Engineer and appropriate public authority, utility company or private owner.

(b) Make arrangements for the damage to be made good without delay to the satisfaction of the public authorities, utility company or private owner as appropriate. The Contractor shall be liable for all costs for making good such damage.

The Engineer may issue instructions or make other such arrangements as he deems necessary, to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

4.14 Setting out the Works

The Engineer shall supply dimensioned drawings, levels and other information necessary to enable the Contractor to set out the Works, at his own cost, such as theodolite levelling instruments in good working condition, all pegs, ranging rods, long measuring rods, marked meters and decimeters and each meter and decimeter numbered, posts and sight-rails, boning rods, moulds, template etc., together with any reasonable number of labourers that may be required and set out the Works and be responsible for the accuracy of the same. The Contractor shall amend at his own cost and to the satisfaction of the Engineer any error found at any stage which may arise through inaccurate setting out unless such error is based on incorrect data furnished in writing by the Engineer, in which case the cost of rectification shall be borne by the Board. The Contractor shall protect and preserve all control points and benchmarks used in setting out the Works till the end of the Defects Liability Period unless the Engineer directs its early removal. The

Contractor should also keep the theodolite and levelling instruments in good working condition throughout the period of construction work on site.

The checking of any setting out or of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

No separate payment will be made for setting out the Works as required. Unit rates quoted by the Contractor for all items will be deemed to have covered the expenses for such setting out.

4.15 Payments of items on lumpsum basis

For which tender premium are applicable.

4.16 Building in Plant supplied under other Contracts

Plant erected under other Contracts if any, in connection with this project, which are required to be built into structures constructed under this Contract will be set to line and level, secured and fixed by the Plant Contractor by such means as will permit the Contractor to complete the building-in without disturbing the line and level of the plant so fixed. Maintaining the alignment during building-in will be the responsibility of the Plant Contractor.

Openings shall be left in concrete walls, floors, roofs, etc., as shown on the Drawings.

Plant and equipment such as pipes and valves supplied under other contracts for building-in by the Contractor shall wherever practicable, be built directly into the Works and any box-outs or holes formed for the convenience of the Contractor shall be made good properly and effectively after the inserts are placed in.

4.17 Preservation of Vegetation

The Contractor shall ensure that his employees, sub-contractors (and also their employees) shall not fetch firewood from the trees around the Site. The Contractor shall be liable for any penalties levied by the concerned authorities for infringement of this regulation.

4.18 Precautions for works in Thoroughfares

While the execution of any work is in progress in any street or thoroughfare, the Contractor at his own cost shall have adequate provision for the passage of traffic, for securing safe access to all premises approached from such street or thoroughfare, and for any drainage, water supply, or means of lighting or any other utility service which may be interrupted to reason of execution of the Work. Whenever it may be necessary to stop the traffic in any street or thoroughfare, permission must first be obtained from the Engineer and the Contractor shall then put up such barriers and adopt such other measures or

take precautions as may be necessary or as the Engineer may direct for regulation of traffic. The work shall in such cases be executed night and day or for as long a period as practicable if so ordered by the Engineer, and with such speed and vigour as he may require, so that the traffic may be impeded for as short a time as possible. The Contractor shall remove the barriers as soon as the necessity for them has ceased. Care shall be taken by the Contractor to cause the least possible obstruction to traffic during the progress of the work.

4.19 Liaisioning with Road Authorities & Precautions during Excavation & Reinstatement

The Contractor shall liaison with road authorities (BBMP, traffic police, etc.) for all necessary permissions, works and reinstatement. Working on the road will require detail planning in relation to heavy traffic, setting out of signs and cones to direct traffic, attending leak repairs and bursts. Contractor shall prepare a scheme and shall submit for Engineer's approval. The authorities may stipulate permitted hours of work and these must be complied with. Trench excavation shall be properly guarded and debris shall be immediately carried away.

Necessary traffic signals and night lighting with diversion signs, cones etc., shall be provided. Entire work shall be properly planned and executed and supervisor who is nominated for the execution of the work must be on site at all times.

4.20 Maintenance of underground utility services

All the underground utility services such as water pipes, gas pipes, drains, sewers, cable etc., which may be met up in or about any excavation, shall if the Engineer deem it practicable, be properly maintained and protected by the Contractor himself or through other agency by means of shoring, strutting, planking over, padding or otherwise as directed by Engineer during the progress of the work without claiming any extra charge. Any damage to these underground utility services shall be immediately remedied by the Contractor or by the agency at his own cost, failing which the Engineer may with or without notice adopt such measures as he may deem necessary at the risk and cost of the Contractor.

If on the other hand, the Engineer considers impracticable for the Contractor to maintain any such underground utility services and that the exigencies of the work necessitate the breaking down, removal or diversion of the said services the cost of such breaking down, removal or diversion including that of rebuilding, replacing, diverting and reinstating of any such utility service shall be paid to the Contractor, if done by him, including the cost of provisions, pumps, chutes or other appliances as the Engineer may direct for the raising or temporary passage of the water or sewage and the cost of pumping out or removing as often as the Engineer may direct, water or sewage which may escape from any such underground utility service.

4.21 Contractor to preserve peace

The Contractor shall at all times during the progress of the work take all requisite precaution and use his best endeavours for preventing any riotous or unlawful behavior by or amongst the workers and others employed on the Works and for the preservation of peace and protection of the inhabitants and the security of property in the neighborhood of the Works. He shall also pay the charges of such special police (if any) as the Engineer may deem necessary.

4.22 Connections to Existing Pipelines

The pipeline constructed under this Contract shall be connected to the pipeline constructed under an other contract. The Contractor shall carry out all works connected with items like road surface / pavement breaking, excavation, diverting the road where necessary, major or minor fixtures, laying pipelines, concreting, backfilling and consolidating, restoring the road / pavement, removing diversion etc., and any other connected items required for this, though not specifically mentioned herein. The Contractor shall arrange all construction equipment, tools, tackles, cranes, diesel generators and / or diesel driven equipment and standby equipment to ensure meeting the scheduled programme. The Contractor shall prepare his programme for this work and submit it for Engineer's review and approval.

4.23 Interface between Contracts

The interface between various contracts linked with this contract has been described in Part 1 of this Specifications. The Contractor shall coordinate fully with the relevant activities of the other Contractors as specified by the Engineer.

4.24 Contractor’s office near the works

The Contractor shall have an office near the Works at which notice from the Employer or the Engineer may be served, and shall between the hours of sunrise and sunset on all working days have a clerk or some other authorised person always present at such office upon whom such notices may be served and service of any notices left with such clerk or any authorised person or at such office shall be deemed good upon the Contractor.

4.25 Effects of Weather

The Contractor shall ensure that no damage occurs to the works during construction by arranging adequate protection for excavations or building works against the effects of drought, sunshine, wind and rainfall (including erosion and flooding). No work shall be performed when in the opinion of the Engineer such work is liable to be injuriously affected by the weather. The Contractor shall have no claim against the BWSSB on account of loss alleged

to have been sustained directly or indirectly by reason of the Engineer declining to permit such work to start or continue or ordering any work damaged by the weather to be made good or removed and re-executed.

End of Part 4

PART-5

TECHNICAL SPECIFICATIONS

PART 5

TECHNICAL SPECIFICATIONS

A. STANDARD SPECIFICATIONS

The "*Standard Basic Specifications* " issued by the Employer, BWSSB, BWSSP(II), set out the specifications that shall be followed for construction of General Works under the BWSSP(II). Specifications for additional specialized items of civil works, and/or for mechanical and electrical works, are as set out in Part B, Particular Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Specifications and the Particular Specifications, the provisions of the Particular Specifications will prevail.

B. PARTICULAR SPECIFICATIONS

CHAPTER -1

INTRODUCTION

1.1 SCOPE

Tenders scope shall broadly include but not restricted to " Providing, laying, jointing, testing and commissioning of RCC NP3 & NP4 class pipes of varying diameters" given in tender documents. Entire work shall be carried out under overall supervision of BWSSB to their full satisfaction.

1.2 DESCRIPTION OF WORK

The major works covered under this tender are given below:

1. Earthwork excavation for trenches of pipe line along the sewer alignment.
2. Manufacture, supply, laying, jointing, testing and commissioning of RCC NP3 class pipes 900/1200/1400 mm diameter
3. Construction of pre-cast and cast in situ RCC machine hole.
4. Bedding as per design needs
5. Connecting the existing mains/sub mains/laterals
6. Remove of existing pipe wherever applicable
7. Cement concrete encasement for sewers that are constructed in the Storm Water Drains (SWD).
8. Refilling the trenches with good quality gravel and carting surplus excavated earth from site.
9. Dismantling of existing structures and construction of temporary diversion structures
10. Field test of pipe line.
11. Trenchless technology
12. Road restoration works
13. Any other works to be carried with the approval of Engineer.

1.3 SPECIFICATION DRAWINGS

The specification drawings are incorporated in tender documents. These drawings are made for tender’s guidance only. "Released for construction" drawings will be issued to the contractor during progress of the work. "Released for" construction" drawings may be revised and revised copies may be issued to the contractor wherever necessary

during execution of the work. It shall be appreciated that for work of this nature included in this contract, there are limitations for issuing construction drawings at tender stage and hence" "Released for Construction" drawings progressively issued during construction broadly conforming to the basic scheme as shown in the tender drawings, shall form a part of the contract. No claim will be entertained on the score that details shown on "Released for Construction" drawings are different from those shown on the tender drawings, unless the drawings indicate such items of work which are not a part of the Bill of Quantities.

1.4 ENVIRONMENTAL IMPACT

The contractor should comply with state and national environmental standards and guidelines.

1.5 MATERIALS

a. The term "Materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the works.

b. Except as may be otherwise specified for particular parts of the Works the provision of Clauses in "materials and workmanship" shall apply to materials and workmanship for any part of the works.

c. All materials shall be new and of the kinds, qualities described in the Contract and shall be at, least equal to approved samples.

d. Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

1.6 SAMPLES AND TESTS OF MATERIALS

a. The Contractor shall submit samples of such materials including FRC machine holes covers, pre-cast concrete blocks, RCC NP3 or pipes as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

b. Samples shall be submitted, and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

c. The Contractor shall give the Engineer seven days’ notice in writing of the date on which any of the materials will be ready

for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed upon date in his presence. The Contractor shall in any case submit to the Engineer within seven days of every test such number of certified copies (not exceeding six) of the test readings as the Engineer may require.

d. Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract particularly as to the provisions of under the Conditions of Contract. The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

1.7 STANDARDS

a. The special attention of the Contractor is drawn to the relevant Sections and Clauses of the National Building Code of India 1984 and Karnataka State Standard Specifications & latest IS Specifications (latest editions as amended) and should follow all the specifications and conditions strictly.

b. Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current at the thirty-first day of December, 1989, unless a more recent amendment is specified hereinafter, or with the requirements of any other authoritative standard approved by the Engineer which shall be no less exacting in the opinion of the Engineer than the corresponding standard quoted herein.

c. Where the relevant standard provides for the furnishing of a certificate to the Employer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

d. The specifications, standards and codes listed below are made a part of this specification. All standards, tentative specifications, specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

e. If no standard is indicated, the relevant Indian Standard, if any, shall apply. Indian standards are published by:

Indian Standards Institution
ManakBhavan, 9, Bahadur Shah Zafar Marg NEW DELHI - 110002

f. In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

i) Materials

Code	Description	Remark
IS:269-1989	Specification for ordinary Portland cement	
IS 383-1970	Specification for coarse and fine aggregates from natural sources for concrete.	
IS: 432	Specification for mild steel and medium tensile steel	
IS: 650-1971	Specification for standard sand used for testing of cement (up to 40-mm diameter) for structural purposes	
IS: 4111-1986	Code of practice for auxiliary structures in sewerage system (Machine hole). Part 1	
IS: 1239 (part-I)	Code for Steel tubes	
IS:651- 1992	Specification for salt-lazed stoneware pipes and fittings	
IS: 458-2003	Specification for recast concrete pipes (with and without Reinforcement).	
IS: 783-1985	Code of Practice for Laying of concrete pipes	
IS: 5382-1985	Specification for Rubber Sealing Rings for Gas Mains, Water Mains and Sewers	
IS: 5455-1969	Specification for Cast Iron steps for machine hole	
IS: 4127-1983	Code of practice for laying of glazed stoneware pipes.	
IS: 1786	Specification for steel high strength deformed bars for concrete reinforcement.	
IS: 4990	Specification for plywood for concrete shuttering works	
IS: 12330-1988	Specification for Sulphate Resistance Portland Cement	

ii) Tests

Code	Description	Remark
IS: 516-1959	Method of test for strength of concrete.	
IS: 1199-1959	Method of sampling and analysis of concrete	
IS: 2386-1963 (Parts I-VIII)	Methods of test for aggregate for concrete.	
IS: 2720 (Parts I-XLI)	Methods of test for soils	
IS: 3025 (Parts1-59)	Method for sampling and test (physical and chemical) for water used in industry	

iii) Codes of Practice

Code	Description	Remark
IS: 456-2000	Code of practice for plain and refined concrete	
IS: 800	Code of practice for use of structural steel in General building construction.	
IS:919	Recommendation for limits and fits for engineering	
IS:'1597 (Parts I & II)	Construction of stone Masonry	

Code	Description	Remark
IS:2502	Code of practice for bending and fixing of bars for concrete.	
IS:2571	Code of practice for laying in situ cement concrete flooring	
IS:3558	Code of practice for use of immersion vibrator for consolidating concrete.	
IS:3935	Code of practice for composite concrete	
IS:4014 (Parts I & II)	Code of practice for steel tabular scaffolding	
IS:10005	SI units and recommendations for the use of their multiples and of certain other units.	

CHAPTER - 2

SUBMITTALS

2.1 DESCRIPTION

This section covers additional requirements for submittals and forms a part of all other sections in which submittals are required. It is subjected to General Conditions of Contract.

Submittal requirements to be included:
1. CPM Progress Schedule
2. Samples
3. Material lists and equipment
4. Factory test reports
5. Certificates
6. Laboratory test reports

2.2 SUBMITTAL REQUIREMENTS

CPM Progress Schedule

Within 30 days of award of the tender, submit a critical path method analysis for construction progress control and make such revisions as are required for approval. Clearly indicate all construction activities, sub activities and mile posts on a time oriented basis, with the critical path fully identified for all activities. Update and resubmit the charts monthly, flag all slippage's and mile posts and attach a narrative description of the proposed corrective actions to the resubmitted charts. Include the following minimum information for each activity and critical path item:

i. Date and initial submittal, as applicable.
ii. Ordering dates for long lead time items.
iii. Dates for materials on site.
IV. Testing and clean up.
V. Final completion and handing over.

2.3 SAMPLES

The Contractor has to submit samples of all materials used for the work prior to start the works and get the approval of the Engineer in charge. Label or tag each sample or set of samples, identifying the manufacturer's name and address, brand name, catalogue number, project title and intended use.

2.4 MATERIAL LISTS AND EQUIPMENT DATA

The Contractor has to submit all material lists. Equipment lists etc. well in advance before starting the work and get the approval from the Engineer in charge.

CHAPTER - 3

SITE PREPARATION

3.1 BENCH MARKS

Permanent bench marks at least one in every kilometer, shall be fixed carried from nearest BWSSB Bench marks before any work is started by the contractor in any section; These benchmarks shall be fixed away from the field of work so as not to be disturbed during the contract Period and shall be accurately fixed in concrete

pillar/pedestal . No separate payment shall be paid towards fixing of bench marks. `

3.2 CLEARING SITE OF LARGE TREES, STRUCTURES ETC.

This shall include the removal of large trees, stumps, structures, services such as cables, water supply, sewerage, storm water drains etc. or parts thereof lying along the alignment of sewer. The contractor should inform the Engineer in charge before removing trees, structures, other services and structures etc. well in advance. Large trees and other valuables are the property of the Government and it should be properly stacked along the side of the road and conveyed to the place as per directions of the departmental Engineer. The cutting of trees or demolitions of structure are done in such a way that it should not disturb the traffic and pedestrians.

3.3 REMOVAL OF TOP SOIL, SHRUBS AND OTHER VEGETATION

The work has to be tackled in between two adjacent machine hole only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material up to a depth of 30 cm between ground level or road level shall be removed. All debris and unsuitable material shall be carted away from the site as per the direction of departmental engineer. The payment against this item as per Bill of Quantities includes loading, unloading, carting the material to a site selected by the contractor at his own cost.

3.4 PREPARATORY WORK, SIGHT-RAILS AND BONING STAVES

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals. Before commencement of earth work excavation, levels shall be taken along the centre line of the proposed sewer at intervals of say 10 m and at the machine holes locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the machine hole is provided with the tender. This L.S may be updated by the contractor and approved by the Engineer before taking up the work.

The width of the trench to be excavated is marked on both sides of the centre line and excavation lines cut out.

Two wooden posts 100 mm x 100 mm x 1800 mm high shall be firmly, erected/fixed across the centre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of all intended excavation such that the poles/posts are not disturbed during the course of execution of the work. These posts are so arranged and fixed that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the machine holes, as the case may be.

The sight-rail made from 250 mm wide x 40 mm thick wooden planks shall be screwed to the poles. The sight-rails shall be truly horizontal. The centre line of the sewer shall be marked on the sight-rail by fixing

a nail or otherwise as determined by the Engineer. The sight-rails may be fixed about 1.25 m above the ground, which is convenient distance for sighting by a leveling instrument. The sight-rails have to be so fixed that when a line sighted along the top edge of the sight-rails shall represent the true fall or gradient of the proposed sewer. This gradient is transferred below the ground level by means of boning-rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boning rods with cross section 75 x 50 mm of various lengths shall be prepared with wood. Each length shall be a certain number of meters and shall have fixed tee-head. (A cross piece of 450x 100 mm is to be fixed with nails at the top of the boning rod so as to form shape like a Tee-square) and a cross piece about 300 mm long fixed at the bottom of the boning staff. The distance between the top of Tee head and the cross piece shall depend upon the site requirements viz, dia of pipe, depth of cutting, level of sight-rail, designed level of sewer, etc. The boning rod must be marked on two sides to indicate its full length. According to the circumstances of each case, a suitable length of boning rod, duly fixing the cross piece, will be determined upon the reduced level of the invert of pipe at each sight-rail.

The sight-rail and vertical posts shall be perfectly square and planed smooth on all sides and edges. This arrangement of erecting poles with sight-rail shall be done at suitable intervals depending on the site requirements, as directed by the Engineer. The posts and rails must in no case be removed until the trench is excavated, the pipes are laid and permission given to proceed with the filling in.

3.5 PROBING PITS

Before starting the excavation of trenches, the contractor shall dig probing pits of size 1 m x 1 m and 1.5 m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probing pits are to be excavated in accordance with the specification for excavation, refilling etc.No separate payment will be made for these probing pits.

3.6 UTILITIES PROTECTION

All utilities within the site, such as water, storm and sewage mains, shall be ascertained by probing pit results at various intervals.

All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations.

Relocation wherever necessary, shall be with the approval of the Engineer and the Utility Authority. Payment will be made as per the Bill of Quantities only for relocating the utilities. Any damage to any utility resulting from the contractor's operations shall be repaired at the contractor's expense.

3.7 PAVEMENT REMOVAL

The contractor must inform the Engineer before the starting of work well in advance so that it can be communicated to other concerned departments. The contractor must provide and maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operating day and night for the full duration of work. The BWSSB shall not be responsible under any circumstances for any mishappenings therefore. For the purpose of payment of removal of pavement, steel tapes are to be used and the measurement shall be taken jointly by the Engineer's representative and contractor or his representative. The width of trenches shall be as per table-1 and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as machine hole, making cross connections, fixing other appurtenances etc. the engineer shall prescribe the dimensions for removal of pavement from time to time.

3.8 MAINTENANCE OF TRAFFIC AND CLOSING OF STREETS

The work shall be carried out in such a manner which will cause the least interruption to traffic, and the road/street may be closed in such a manner that it causes the least interruption to traffic, Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

3.9 INTERRUPTION TO SERVICE

No valve or other control of the existing services shall be operated without the permission of the authority.

3.10 WORK DURING NIGHTS

It is expected that the intensity of traffic is likely to be less in the nights from 22.00 hours to 5.00 hours. Hence, for efficient uninterrupted work, the contractor shall equip himself with the required manpower, materials, and machinery to do the work exclusively in the above periods alone. No separate payment will be made for doing the work in the nights. The contractor shall get prior approval from the Engineer-in-charge before starting the work during nights.

CHAPTER-4

EARTH WORK

4.1 DESCRIPTION

The work specified in this section includes the provision of all labour, machinery, construction equipment and other appliances required to perform all earth work shown on the drawing or otherwise specified or required, in a sound, workmanlike manner.

4.2 GENERAL

Excavation shall be required to be done for the following works:

a) Excavations for underground sewer lines
b) Excavations for sewer lines below storm water drains
c) Excavations for machine hole, footings, pedestals etc.
d) No separate payment shall be made for removal of shrubs, grass, large and small bushes, trees, stumps and stems of trees cut, fencing including posts and gates

4.3 SOIL INVESTIGATIONS

Soil analysis reports of proposed sewer alignment are available with BWSSB officials. Additional soil tests if necessary shall be carried out along the alignment and the soil boring logs shall be prepared by the contractor at his own cost. Where off-site materials have to be used, the contractor shall, if the Engineer desires make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content etc. from an approved testing laboratory.

4.4 CLASSIFICATION

The excavation work shall be classified into the following categories:

a) For sewer line trenches

i) Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with fair sized boulders, hard disintegrated rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars,

ii) Hard rock and boulders to be removed only by chiseling and benching/diamond rope cutting.

b) Machine hole, pedestals etc.

i) Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth and earth mixed with fair sized boulders, hard

disintegrated rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars.

ii) Hard rock and boulders to be removed by benching and chiseling/diamond rope cutting.

4.5 TRENCH EXCAVATION
GENERAL

Trench excavation means excavation of trenches into which the pipe is to be laid. The line and levels of trenches shall be as shown on the drawings or as may be directed by the Engineer in charge. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer in charge.

4.6 WIDTH OF TRENCH

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. The widths to be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes.

4.7 DEPTH OF EXCAVATION OF TRENCH

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding will be paid. The depth of excavation for machine hole shall be measured from the surface of the existing ground level to the bottom of foundation. No payment will be given beyond this depth.

4.8 MAXIMUM LENGTH OF OPEN TRENCH

The stretch of work to be tackled shall be limited to two adjacent machine hole. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent machine hole to ensure lying and jointing of pipes can reasonably be expected to be completed and the trench refilled not attention later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

4.9 TRENCH SIDES

Loose boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, and the trench sides shall be stabilized with screening or other methods approved by the Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

4.10 WIDENING TRENCH AT JOINTS, ETC.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the contractor.

4.11 OVER-EXCAVATION OF TRENCH BOTTOMS

All excavation carried below the grades shown on drawings, shall be refilled with compacted bedding material at the Contractor's expense.

4.12 EXCAVATED MATERIAL

The material from the excavation shall be deposited on either side of the trench leaving clear berm on one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing the side of the trench to slip or fall, or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, machine holes covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

The excavated soil should be so placed and handled as not to inconvenience the usual traffic, till it is carted away. The contractor should also provide necessary bridging over the excavated trenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost; if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect..

The machine holes frames and covers from the existing machine hole shall be carefully removed and stored in a suitable place away from the trenches. The contractor should not break the machine holes frames and covers while removing. The contractor is responsible for the safety of machine holes frames and covers.

4.13 PIPE BEDDING

i) Granular Bedding

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be natural sand (free from cinders, ashes, slag, refuse, organic materials, boulders, rocks or stones) graded from fine to coarse. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

ii) Concrete Bedding

This type of bedding is as per the drawing appended with the tender document, and is to be provided at locations shown in the Longitudinal Section drawings or as specified by the Engineer. A concrete bedding using M15 is to be adopted. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with reinforced cement concrete grade as mentioned in BOQ or as directed by Engineer Incharge with a minimum thickness of 150 mm all around or as per bedding drawing. if the clear distance between bed and pipe top is less than one meter.

4.14 TRENCH EXCAVATION IN HARD ROCK

If any material which in the opinion of the Contractor can be classified as rock, is encountered, he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

Only such proportion of material notified and measured which is certified by the Engineer as "rock", shall be paid for as rock excavation.

Excavation for trenches in rock shall be so carried out that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paid for and any additional expenses incurred in providing additional strength to the pipe to overcome the increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer and the auctioned amount shall be remitted to the Employer/Engineer

4.15 EXCAVATION FOR APPURTENANCES

Excavation in trenches for foundation of machine hole, pedestals etc. shall be as per the plan or as directed by the Engineer. The dimensions of the excavation shall be measured as the projection in plan of the outermost edges of the structure.

4.16 PUMPING SEWAGE OR DIVERSION BY GRAVITY AND DEWATERING

General

The works included in this Section are as follows:

1) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition and free from sewage flow in all areas in which the work in this contract is to be executed.
2) Continuous operation of the dewatering systems is required to complete all portions of the works where dewatering and pumping of sewage is necessary to prevent inflow, collection of surface water or ground water, or sewage or to protect adjacent properties or constructions from damage resulting from a rise or fall of ground water levels or sewage.
3) Removal of the equipment when no longer required.

4.17 PUMPING SEWAGE

1) The existing sewer, which has to be replaced, and existing machine holes which has to be dismantled or reconstructed, are having house connections which contribute sewage. The contractor is expected to tackle a stretch in between two adjacent machine hole. The contractor should make arrangements as detailed below for pumping the incoming sewage to enable to dismantle machine hole, approved sewers and reconstruct new machine hole and relay new sewers in the same alignment.
2) Temporary pumps are to be installed and temporary pipes provided to pump sewage from upstream machine holes selected by him to a downstream machine holes. Alternatively, it can be diverted by the gravity, if possible.
3) Temporary pumps should also be installed and temporary pipes provided to intercept the sewage flows entering the sewers and machine hole from house connections and pump out or divert by gravity, if possible into a downstream machine holes. Alternatively, the sewage coming from house connections can be diverted, if possible by gravity through pipes or channels into the nearest machine holes.
4) Suitable precast/prefabricated cisterns have to be provided to intercept incoming sewage
at machine hole and house connections in which pumps can be installed.

5) This pumping arrangement and diversion arrangement has to be kept functional till the stretch of sewer is completed and commissioned. Stand-by pumping equipment may be kept in safe to ensure continuous pumping of the sewage so that the existing sewerage system is functional during the period of relaying the new sewer.

4.18 PUMPING OUT WATER

The contractor shall provide and work at his own cost all pumps, engines and machinery requisite to keep the trenches for the sewers or foundations and all other excavations clear of water, whether subsoil water, storm water, sewage, leakage from tanks, wells, drains, sewers, water mains or pipes etc., so that there may be no accumulations of such water and that no setting out may be done, no masonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated so after as the Engineer may consider necessary. The pumps and power applied must be such as the Engineer may consider necessary for the work to set. The pumps and power applied must be such as the Engineer may determine to be sufficient to any particular time, or he may himself supply pumps and power at contractor's expense, so he may stop the work altogether until he is satisfied and also impose a fine upon the contractor.

4.19 KEEP EXCAVATION CLEAR OF WATER

Where ground water is encountered or anticipated the contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made

available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

4.20 BARRICADING, WATCHING, LIGHTING

The parts of the barricading shall be of timber, securely fixed in the ground not more than 2.50 m apart. They shall not be less than 10 cm in diameter and not less than 1.5 m above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 0.50 m above the ground and each shall be of 5 cm to 10 cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes. The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so required by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be kept to see that this is properly done and maintained. In addition to the normal lighting arrangements the contractor shall provide, whenever such work is in progress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along-the road. In the event of the contractors not complying with the provisions of the clause, they will be imposed a fine at Rs.500/- per day. Further, in all such cases the work may be carried out departmentally at the risk and cost of the contractor. The contractor shall be held responsible for all claims for compensation as a result of accident or injury to person and non-provision of red flags.

The contractor shall at his own cost provide all notice boards before opening of roads as directed by the Engineer.

Arrangements shall be made by the contractors to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

4.21 REFILLING TRENCHES

1) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the contractor shall not permit unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.
2) The trench shall be filled by borrowed gravel up to at least 30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.

3) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.
4) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.
5) Filling-in shall be done in layers not exceeding 200 mm in thickness accompanied by adequate watering, ramming, etc., so as to get good compaction up to 300 mm above the top of the pipe. Above this level, useful excavated earth free from boulders shall be placed in layers of 225 mm, watered and compacted by tamping. Wherever pipe is laid in the storm water channel, total refilling shall be done with borrowed earth.
6) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.
7) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.
8) In case of sewers laid in storm water channels, after refilling is done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm.
9) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density (MDD) test for the refilled soil in trench to confirm the proper compaction up to 95% of maximum dry density.

4.22 REFILLING THE ROAD SURFACE

After the backfilling is completed, the contractor shall restore the surface of the trench over the pipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The work of restructuring of road surface either by bitumen or cement concrete shall be as described in chapter Road restoration.

4.23 SUBSIDENCE IN FILLING

Should any subsidence take place in the filling at any place of work i.e. at machine hole and over pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at his own cost or the engineer may with or without notice to the contactor make good the same in any way and with any material that he may think proper, and at the expense of the contractor. The engineer may also, if he anticipates the occurrence of any subsidence, take necessary action deemed fit in which case also the expenses therefore shall be charged to the contractor.

4.24 DISPOSAL OF EXCAVATED MATERIALS

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer in charge for which no separate payment will be made.

4.25 ALL WORKS TO BE CLEAR, CLEAN AND PERFECT

The contractor, after completion of entire work and before seeking settlement of his final bill, shall prove at his expense that the entire line is clear, clean and perfect in the presence of the Engineer or his authorized subordinate. He should provide suitable instruments, appliances etc., and pass them through the pipes and shall show that water passes freely through the entire reach from higher end to lower end.

Note: Necessary precautions such as those indicated hereunder may be taken by the contractor while checking the completed sewer line for its effective functioning, wherever required.

The machine hole should be kept open, as required for one hour prior to the starting of checking operations and should be so kept open during the whole duration of checking operations. This is to be done for allowing the gases to escape, naturally. In order to prevent the fire and explosions, .endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the machine holes.

Meshes should be placed over the opened machine hole to prevent pedestrians etc., from falling in. Likewise, caution boards printed in fluorescent letters such as "DANGER MACHINE HOLES IS KEPT OPEN" etc., shall be provided.

4.26 MEASUREMENT AND PAYMENT

The payment of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width shown in the drawings.

a) Trench excavation

The length of the trench excavation shall be measured along the centre line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the level of the bottom of the pipe line. The width of the trench shall be measured on the basis of vertical side walls and the specified widths. No additional payment shall be

made for the widening at sockets, specials, hunching or surrounds beyond the dimensions specified.

b) Structures

Measurement for structure excavation shall be made as per the projection in plan of the outermost edges of the, structure as per the plan at the bottom.

c) Rock excavation

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation plus 150 mm both for structure. and trench excavations.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradling or hunching concrete that may be specified or ordered by the Engineer as a consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock and the revenue generated in this manner will be recovered in his payment at the prevailing rate of Royalty with applicable GST

d) Disposal of excavated material

All the excavated material shall be carted away and the contractor shall be paid as per the Bill of Quantities and it includes loading, unloading, transporting to a site as per Engineers directions.

If the Engineer decides that there will be no hindrance to traffic by not carting away the excavated material, he will give direction accordingly. In such case, payment will be restricted to only such quantities carted out.

CHAPTER 5

CONCRETE AND ALLIED WORKS

5.1 GENERAL

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer in-charge shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer-in-charge's approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected.

5.2 APPLICABLE CODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein this bid document, this specification shall govern.

5.2.1 Materials

IS: 269 - Specification for 33 grade ordinary Portland cement

IS: 455 - Specification for Portland slag cement.

IS: 1489 - Specification for Portland-pozzolana cement.

IS: 8112 - Specification for 43 grade ordinary Portland cement.

IS: 12330 - Specification for Sulphate resisting Portland cement.

IS: 383 - Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 - (Parts-I & II) Specification for mild steel and medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.

IS: 1566 - Specification for hard-drawn steel wire fabric for (Part-I) concrete reinforcement.

IS: 9103 - Specification for admixtures for concrete.

IS: 2645 - Specification for integral cement waterproofing compounds.

IS: 4990 - Specification for plywood for concrete shuttering work.

5.2.2 Material Testing

IS: 4031 - Methods of physical tests for hydraulic cement. (Parts-1 to 13)

IS: 4032 - Method of chemical analysis of hydraulic cement.

IS: 650 - Specification for standard sand for testing of cement.

IS: 2430 - Methods for sampling of aggregates for concrete.

IS: 2386 - Methods of test for aggregates for concrete. (Parts-I to VIII)

IS: 3025 - Methods of sampling and test (physical and chemical) water used in industry.

IS:6925 - Methods of test for determination of water-soluble chlorides in concrete admixtures.

5.2.3 Materials Storage

IS: 4082 - Recommendations on stacking and storing of construction materials at site.

5.2.4 Concrete Mix Design

IS: 10262 - Recommended guidelines for concrete mix design.

SP: 23 -Handbook on Concrete Mixes. (S & T)

5.2.5 Concrete Testing

IS: 1199 - Method of sampling and analysis of concrete.

IS: 516 - Method of test for strength of concrete.

IS: 9013 - Method of making,curing and determining compressive strength of accelerated cured concrete test specimens.

IS: 8142 - Method of test for determining setting time of concrete by penetration resistance.

IS: 9284 - Method of test for abrasion resistance of concrete.

IS: 2770 - Methods of testing bond in reinforced concrete.

5.2.6 Equipment

IS:1791 - Specification for batch type concrete mixers.

IS:2438 - Specification for roller pan mixer.

IS:4925 - Specification for concrete batching and mixing plant.

IS:5892 - Specification for concrete transit mixer.

IS:7242 - Specification for concrete spreaders.

IS:2505 - General Requirements for concrete vibrators: Immersion type.

IS:2506 - General Requirements for screed board concrete vibrators.

IS:2514 - Specification for concrete vibrating tables.

IS:4656 - Specification for form vibrators for concrete.

IS:11993 - Code of practice for use of screed board concrete vibrators.

IS:7251 - Specification for concrete finishers.

IS:2722 - Specification for portable swing weigh batchers for concrete (single and double bucket type).

IS:2750 - Specification for steel scaffoldings.

5.2.7 Codes of Practice

IS:456 - Code of practice for plain and reinforced concrete.

IS:457 - Code of practice for general construction of plain and reinforced

concrete for dams and other massive structures.

IS:3370 - Code of practice for concrete structures for storage of liquids. (Parts-I to IV)

IS:3935 - Code of practice for composite construction.

IS:2204 - Code of practice for construction of reinforced concrete shell roof.

IS:2210 - Criteria for the design of reinforced concrete shell structures and folded plates.

IS:2502 - Code of practice for bending and fixing of bars for concrete reinforcement.

IS:5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS:2751 - Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

IS:9417 - Specification for welding cold worked bars for reinforced concrete construction.

IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.

IS:3414 Code of practice for design and installation of joints in building.

IS:4326 - Code of practice for earthquake resistant construction of building.

IS:4014 - Code of practice for steel tubular scaffolding. (Parts-I & II)

IS:2571 - Code of practice for laying in-situ cement concrete flooring.

IS:7861 - Code of practice for extreme weather concreting.
Part-I : Recommended practice for hot weather concreting.
Part-II : Recommended practice for cold weather concreting.

IS:13920 - Ductile Detailing of Reinforced Concrete Structure subjected to seismic forces.

SP-16 - Design Aids for Reinforcement Concrete to IS: 456-1978 (S&T) - 1980

SP-24 - Explanatory Handbook on IS: 456-1978

SP-34 - Handbook on Concrete Reinforcement and Detailing

(S&T) – 1987

5.2.8 Construction Safety

IS:3696 - Safety code for scaffolds and ladders. (Parts-I & II)

IS:7969 - Safety code for handling and storage of building materials

IS:8989 - Safety code for erection of concrete framed structures.

5.2.9 Measurement

IS:1200 - Method of measurement of building and engineering works (Part I-28).

IS:3385 - Code of practice for measurement of civil engineering works..

5.3 MATERIALS FOR STANDARD CONCRETE

The ingredients to be used in the manufacture of concrete shall consist solely of Ordinary Portland Cement, and Sulphate resistant cement clean sand, natural coarse aggregate, clean water, and admixtures, if specifically called for on conditions at site warrant its use. Only river sand shall be used for all works.

5.3.1 Cement

The contractor will have to make own arrangements for procuring cement and steel.

The Contractor will have to make his own arrangements for transport from supplier godown and storage of adequate quantity of cement. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer-in-charge. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time the Engineer-in-charge have reasons to consider that any cement is defective, then irrespective of its origin,

date of manufacture and or manufacturer's test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. Testing certificates for each batch of cement should be submitted by the contractor to the Engineer in charge, before starting the concreting work. The Contractor shall not be entitled to any claim of any nature on this account.

5.3.2 Aggregate

5.3.2.1 General

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete (Vide BIS 456 & BIS 383) and confirming to tests as per BIS: 2386 (Part I to VI)

"Coarse Aggregate" is aggregate most of which is retained when passed through on 4.75 mm BIS sieve.

All fine and coarse aggregates proposed for use in the works shall be subject to the Engineer-in-charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-charge.

Aggregates shall consist of natural sands, stone (crushed or uncrushed) and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later. Aggregate source shall be approved by BWWSSB.

Sampling and Testing

Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates, shall be furnished to Engineer in-charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the contractor.

5.3.2.2 Storage of Aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall

be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in

height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

5.3.2.3
Specific Gravity

Aggregates having a specific gravity below 2.4 (saturated surface dry basis) shall not be used.

5.3.3 Fine Aggregate

a. Fine aggregate shall consist of natural or crushed sand conforming to BIS 383 confirming to tests as per BIS 2386 part I to VI. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt, or other deleterious substances, which can be injurious to the setting qualities/strength/durability of concrete.

b. Screening and Washing: Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.

c. **Foreign Material limitations: The** percentage deleterious substances in sand delivered to the mixer shall not exceed the following:

Table 1: Foreign Material Limitations in Fine Aggregate

S.No.	**Foreign Material**	**Percentage by weight**	
		Uncrushed	**Crushed**
1	Material finer than 75 micron BIS	3.0	15.0
2	Shale	1.0	-
3	Coal & Lignite	1.0	1.0
4	Clay lumps	-	1.0
Total		5.0	17.0

d. **Gradation: Unless** otherwise directed or approved by the Engineer-in-charge, the grading of sand shall be within the limits indicated hereunder:

Table 2: Grading of Sand for Fine Aggregate

BIS: Sieve Designation	**Grading Zone I**	**Grading Zone II**	**Grading Zone III**	**Grading Zone IV**
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-90	90-100
600 µm	15-34	35-59	60-79	80-100

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 microns IS sieve, by total amount not exceeding 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to grading zone IV shall be used.

Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

Fineness Modulus: The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 microns and 150 microns) and dividing the sum by 100.

5.3.4 Coarse Aggregate

Coarse aggregate for concrete, except as noted above, shall conform to IS 383 & IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

Screening and Washing: Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer in-Charge.

5.3.4.1 Grading

i) Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits:

BIS: Sieve Size	**Percentage passing for single sized aggregate of normal size**					**Percentage passing for graded aggregate of normal size**			
	40 mm	**20 mm**	**16 mm**	**12.5 mm**	**10 mm**	**40 mm**	**20 mm**	**16 mm**	**12.5 mm**
63 mm	100	-	-	-	-	-	-	-	-
40 mm	85-100	100	-	-	-	95-100	100	-	-
20 mm	0-20	85-100	100	-	-	30-70	95-100	100	100
16 mm	-	-	85-100	100	-	-	-	90-100	-
12.5 mm	-	-	-	85-100	100	-	-	-	90-100
10 mm	0-5	0-20	0-30	0-45	85-	10-35	25-55	30-70	40-85

					100				
4.75 mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	-	-	-	-

ii) The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only within tolerance limits which will not affect adversely the strength and or durability of concrete. The maximum size of coarse aggregate shall be 40 mm for M-7.5 and M-10 and 20mm for M-15 to M-20 concrete, or as directed by the

BIS Sieve Size (m	Percentage passing for single sized aggregate of normal size					Percentage Passing For Graded Aggregate Of			
	40	20	16 mm	12.5 mm	10	40 mm	20 mm	16 mm	mm
63	100	-	-	-	-	100	-	-	-
40	85-100	100	-	-	-	95-100		-	-
20	0-20	100	100	-	-	30-70	95-100	100	
16	-	-	85-100	100	-	-	-	90-100	
12.5	-	-	-	85-100	100	-	-	-	90-
10	0-5	0-20	0-30	0-45		10-35	25-35	30-70	40-
85-4.75	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	
2.36	-	-	-	-	0-5	-	-	-	-

Engineer-in-charge or specified otherwise. The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than 1/4th of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller.

5.3.4.2 Foreign material limitations

The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following:

Table 3: Foreign Material Limitations in Coarse Aggregate

S.No.	Foreign Material	Percentage by weight

		Uncrushed	**Crushed**
1	Material finer than 75 micron BIS Sieve	3.0	3.0
2	Coal and Lignite	1.0	1.0
3	Clay Lumps	1.0	1.0
4	Soft Fragments	3.0	-
Total		8.0	5.0

5.3.5 Water

a. Water used for washing, mixing and curing shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and curing concrete. Physical and chemical analysis of the water should be submitted to the Engineer-in-charge, before starting the work.
b. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.
c. Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of BIS: 516.
d. The initial setting time of test block must be made with the appropriate test cement and the water proposed to be used. It shall not be less than 30 minutes and shall not differ by more than + 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test block shall be prepared and tested in accordance with the requirements of BIS: 4031.
e. Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values.
    1. To neutralise 200 ml sample of water, using phenolphthalein as indicator, it should not require more than 2 ml of 0.1 normal NaOH. The details of test shall be as given in BIS: 3025.
    2. To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 Normal HCl. The details of test shall be as given in BIS: 3025.
    3. Percentage of solids, when tested in accordance with the method indicated below shall not exceed the following:

5.4 CONTROLLED CONCRETE

All concrete in the works shall be “Controlled Concrete” as defined in IS: 456 except for M-7.5 and M-10 for which normal mix concrete shall be used. Whether reinforced or otherwise, all concrete works to be

carried out under this specification shall be divided into the following classifications:

Note: It shall be very clearly understood that whenever the grade of concrete such as M-20, etc. is specified it shall be contractor's responsibility to ensure the minimum crushing strength stipulated for the respective grade of concrete is obtained at works. Minimum cement content in the concrete used for liquid/water retaining strength shall be 390 kg/cu.m for 20 mm downgraded aggregate.

Class	**Preliminary Test N/mm^2**		**Works Test N/mm^2**		**Maximum size of aggregate mm**	**Locations for use**
	At 7 Days	**At 28 Days**	**At 7 Days**	**At 28 Days**		
M40	33.5	50.0	27.0	40.0	20	As indicated in the specifications or as required
M30	25.0	38.0	20.0	30.0	40 or 20	-do-
M25	22.0	32.0	17.0	25.0	40 or 20	-do-
M15	13.5	20.0	10.0	15.0	40 or 20	-do-

5.5 MIX DESIGN

5.5.1 General

This is essential for investigating the grading of aggregates, water-cement ratio, workability and the quality of cement required to give preliminary and works cubes of the minimum strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Determination of mix proportions shall be carried out according to "Recommended guidelines for Concrete Mix Design" conforming to IS: 10262.

Whenever there is a change either in required strength of concrete, or water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing proportions, over-wet mixes shall always be avoided.

While fixing the value for water/cement ratio for preliminary mixes, assistance may be derived from the graph (Appendix A, BIS 456 showing the relationship between the 28 day compressive strengths of concrete mixes with different water/cement ratios and the 7-day compressive strength of cement tested in accordance with IS: 269.

5.5.2 Preliminary tests

Test specimens shall be prepared with at-least two different water/cement ratios for each class of concrete, consistent with work ability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually

employed in the works as the object of these tests is to determine the properties of cement, aggregates and water necessary to produce concrete of required consistency and to give the specified strength, it will be contractor's sole responsibility to carry out these tests and he shall therefore furnish to Engineer-in-Charge a statement of proportions proposed to be used for the various concrete mixes. For preliminary tests, the following procedure shall be followed.

Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water cement and aggregates for each batch shall be determined by weight to an accuracy of 1 part in 100 parts.

Mixing concrete shall be done by hand (for small quantities, as directed by Engineer-in-Charge) or in a small batch mixer as per IS: 516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in color. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minutes until the resulting concrete is uniform in appearance. Each batch of concrete shall be such a size as to leave about 10% excess concrete, after moulding the desired number of test specimens.

The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1199. If in the slump test, care is taken to ensure that no water or other material is lost, the material used for the slump test may be re-mixed with the remainder of the concrete for making the specimen test cubes. The period of re-mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

The samples for compression tests of concrete shall be made as per IS: 516 on 15 cm cubes. Each mould shall be provided with a metal base plate having a plate surface so as to support the mould during filling without leakage. The base plate shall be preferably attached to the mould by springs or screws. The parts of the mould when assembled shall be positively and rigidly held together. Before placing concrete, the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the following limits. Height and distance between the opposite faces of the mould shall be of specified size +0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom faces of mould shall be 90-degree +0.5 degree. The interior faces of the mould shall be plane surfaces with a permissible variation of 0.03 mm.

Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS 516.

Curing shall be as specified in IS 516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27°C + 2°C for 24 hours +2 hours from the time of adding water to the dry ingredients. Thereafter they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27°C +2 degree C temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-charge. The test results shall be accepted by the Engineer-in-charge if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Engineer-in-charge may direct the contractor to repeat the tests if the results are not satisfactory and also make such changes, as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by the contractor at his own cost in an approved laboratory.

5.6 PROPORTIONING, CONSISTENCY, BATCHING AND MIXING OF CONCRETE

The determination of the water cement ratio and proportion of aggregates to obtain the required strength shall be made from preliminary tests by designing the concrete mix. Controlled concrete shall be used on all concrete work complying with all the requirements of IS: 456. Cube tests shall be carried out by the contractor on the trial mixes before the actual concreting operation starts. Based on the strength of the concrete mix sanction for the use has to be obtained from engineer in charge.

If during the execution of the works it is found necessary to revise the mix because of the cube tests showing lower strengths than the required one due to inconsistency of quality of material or otherwise, The Engineer in charge shall ask for fresh trial mixes to be made by the contractor. No claim to alter the rates of concrete work shall be entertained due to such change in mix variations, as it is the contractor’s responsibility to produce the concrete of the required grade.

Great care shall be exercised when mixing the actual works concrete using the proportions of the selected trial mix. The final concrete mix shall have the same proportions of cement, fine and coarse aggregates and water as that of the approved selected mix.

A reasonable number of bags should be weighed separately to check the Net weight, where the weight of cement is determined by accepting the manufacturer's weight per bag at the site. Proper control of mixing water is deemed to be of paramount importance. If mixers with automatic addition of water are used, water should be either measured by volume in calibrated buckets, tins or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked and certified and the Engineer-in-Charge's approval obtained.

The Engineer-in-Charge may require the contractor to carry out moisture content tests in both fine and coarse aggregates. The amount of the added water shall then be adjusted to compensate for any observed variations in the moisture contents. BIS: 2386 shall be referred to for determination of moisture content.

No substitution in material, used on the work or alteration in the established proportions shall be made without additional tests to show that the quality and strength of concrete are satisfactory. No alterations shall be permitted without the prior sanction of the Engineer-in-Charge.

5.7 MIXING OF CONCRETE

The mixing of concrete shall be strictly carried out in an approved type of mechanical Concrete mixer. The mixing equipment shall be capable of combining the aggregates. Cement and water within the specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation. The entire batch shall be discharged before recharging. Mixing periods shall be measured from the time when all of the solid materials are in the mixing drum, provided that all of the mixing water shall be introduced before one fourth of the mixing time has elapsed. The mixing time in no case shall be less than two minutes. The mixer speed shall not be less than 14 nor more than 20 revolutions per minute.

Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. Hand mixing of concrete shall not be permitted at all.

5.8 GRADE OF CONCRETE

The different grades of concrete specified shall conform to the strengths as required by IS: 456-1987.Standard deviation shall be calculated as stated in 14.5 of IS: 456-1978. The acceptable criteria for concrete shall be as stated in clause 15 of IS: 456 -1978.The assumed standard deviations as given in table 6 of IS: 456-1978 has to be followed and are given here under. However, the minimum cement content shall be as per "*Table 4: Grade of Concrete*" in this tender document.

Table 4: Grade of Concrete

Grade of	**Assumed Standard Deviation**

Concrete	N/sq.mm
M10	2.3
M15	3.5
M20	4.6

In order to get a quick idea of quality of concrete the optional tests are conducted as stipulated in 14.1.1 of IS: 456-1978 and the results are analyzed according to table 5 on page 41 of IS: 4561978.

5.8.1 Controlled Concrete

Controlled concrete shall be used on all concreting works except where specified otherwise the mix proportions for all grades of concrete shall be designed to obtain strengths corresponding to the values specified in "*Table 5: Compressive Strengths at 28 days*" below for respective grades of concrete.

Table 5: Compressive Strengths at 28 days

Grade	Specified Characteristic Compressive Strength (Works strength) at 28 days
M 10	10
M 15	15
M 20	20

The maximum Water: Cement ratio for all controlled concrete works shall be as specified in IS: 456-1978 as Preliminary tests as specified in the BIS code and required by the Engineer-in-Charge shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative samples of aggregates and cement expected to be used on the job to ascertain the ratios by weight of cement of total quantity of fine and coarse aggregates and the water cement ratio required to produce a concrete of specified strength and desired workability.
The minimum cement content for each grade of concrete shall be as per "*Table 6: Minimum Cement Content in Concrete*" below:

Table 6: Minimum Cement Content in Concrete

Grade of Concrete	Minimum Cement Content in Concrete
M10	220 kgs
M15	240 kgs
M20	330 kgs
M25	360 kgs
M30	360 kgs

At least 4 (four) trial batches are to be made and 7 test cubes should be taken for each batch noting the slump on each mix. These cubes shall then be properly cured and two cubes for each mix shall be tested in a testing laboratory approved by the Engineer-in-Charge at 7 days and others at 28 days for obtaining the ultimate compressive strength. The test reports shall be submitted to the Engineer in charge. The cost of mix design and testing shall be borne by the contractor. On the basis

of the preliminary test reports for trial mix, a proportion of mix by weight and water cement ratio will be approved by the Engineer in charge, which will be expected to give the required strength. Consistency and workability and the proportions so decided for different grades of concrete shall be adhered to during all concreting operations. If however at any time the Engineer-in-Charge feels that the quality of material, being used has been changed from those used for preliminary mix design, the contractor shall have to run similar trial mixes to ascertain the mix proportions and consistency.

The mix once approved must not be varied without prior approval of the Engineer-in-Charge. However should the contractor anticipate any change in the quality of future supply of materials than that used for preliminary mix design, he shall inform the same to the Engineer in charge and bring fresh samples sufficiently ahead to carry out fresh trial mixes. The engineer in charge shall have access to all places and laboratory where design mix is prepared. Design mix will indicate by means of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed.

In designing the mix proportions of concrete, the quantity of both cement and aggregate shall be determined by weight. All measuring equipment shall be maintained in clean and serviceable condition and their accuracy periodically checked.

To keep the water cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and course aggregates and determination of the same shall be made as frequently as directed by the Engineer-in-Charge. The determination of moisture contents shall be according to IS: 2386 (Part III).

5.8.2 Strength Requirements

Where ordinary Portland cement conforming to IS: 269 or Portland blast furnace slag cement conforming to IS: 455 are used the compressive strength requirements for various grades of concrete shall be as shown in table below. Where rapid hardening Portland cement is used the 28 days compressive strength requirements specified in Table- hereunder shall be met in 7 days. The strength requirements specified in table shall apply to both controlled concrete and ordinary concrete

Table 7 : Strength Requirements of Concrete

Grade of Concrete as per IS: 456-1978	**Minimum Compressive Strength in Accordance with IS: 516 (In kg/cm)**			
	For 15 cm cube specimen at 7 days		**For 15 cm cube specimen at 28 days**	
M15	100	135	150	200
M20	135	175	200	260
M25	170	220	250	320

Other requirements of concrete strength as may be desired by the Engineer in charge shall be in accordance with Indian Standard IS: 456 (latest revision). The acceptance of strength of concrete shall be as per clause 5.4 “Sample size and Acceptance Criteria” of IS: 456 (latest revision) subject to stipulation and/or modifications stated elsewhere in this specification if any.

Concrete work found unsuitable for acceptance shall have to be dismantled and replaced to the satisfaction of the Engineer-in–Charge by the contractor free of cost of the owner. No payment will be made for the dismantled concrete, the relevant Formwork and reinforcement, embedded mixtures etc. wasted in the dismantled portion shall be made. In the course of dismantling if any damage is done to the embedded items or adjacent structures, the same shall also be made good free of charge by the contractor to the satisfaction of the Engineer in charge. If the water quantity has to be increased in special cases, cement also is increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete.

5.8.3 Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer-in-Charge, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests

5.8.4 Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the contractor shall obtain the approval of the Engineer-in-Charge in a “Pour Card” maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of test cubes to be taken, finishing to be done and any admixture to be added etc.

5.9 SAMPLING AND TESTING CONCRETE IN THE FIELD

a) Facilities required for sampling materials and concrete including whether proof buildings to house the facilities in the field, should be provided by the contractor at no extra cost. The following equipment with operator shall be made available in serviceable conditions.

i. Concrete cube-testing machine suitable for 15 cm cubes of 100 tonnes capacity with proving calibration ring - 1 no.
ii. Cast iron cube moulds 15 cm size - 6 nos. (min)
iii. Slump cone complete with tamping rod - 1 set
iv. Laboratory balance to weigh upto 5 kg with sensitivity of 10 gm - 1 no.
v. BIS sieves for coarse and fine aggregates - 1 set
vi. Set of measures from 5 litres to 0.1 litre - 1 set

vii. Electric oven with thermostat upto 120°C - 1 no.
viii. Flakiness gauge - 1 no.
ix. Elongation index gauge - 1 no.
x. Sedimentation pipette - 1 no.
xi. Calibrated glass jar 1.0 litre capacity - 2 nos.
xii. Glass flasks and metal containers - As required
xiii. Chemical reagents like sodium hydroxide, tannic acid, litmus paper etc. - As required
xiv. Laboratory balance of 2 kg capacity and sensitivity of 1 gm - 1 no.

b) No concrete of any kind may be placed until the field concrete testing laboratory as specified is provided to the satisfaction of the Engineer. The contractor shall notify the Engineer in advance of all concrete and concrete material testing as provided in the clause to provide the Engineer/his representative with an opportunity to witness all prescribed tests.

c) At least 6 test cubes of each class of concrete shall be made of every 50cum concrete or part thereof or from different batches as directed by Engineer-in-charge. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The cubes must be casted from various batches to arrive at an average strength. The laboratory test results shall be tabulated and furnished to the Engineer. The Engineer will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength.

d) Consistency: Slump tests shall be carried out as often as requested by the Engineer and invariably from the same batch of concrete from which the test cubes are made. Slump tests shall be done immediately after sampling.

5.10 CONCRETE TESTS

The Engineer-in-Charge, may order tests to be carried out on cement, sand, coarse aggregate, and water in accordance with the relevant Indian standards.

Tests on Cement shall include:

- Fineness test
- Test for normal consistency
- Test for setting time
- Test for soundness
- Test for tensile strength
- Test for compressive strength
- Test for heat of hydration (by experiment and by calculations) in accordance with BIS 269

Tests on Sand shall include:

- Sieve test
- Test for organic impurities
- Decantation test for determining clay and silt content
- Specific gravity test
- Test for unit weight and bulkage factor
- Test for sieve analysis and fineness modulus

Tests on Coarse Aggregate shall include:

- Sieve analysis
- Specific gravity and unit weight of dry, loose and rodded aggregate
- Soundness and alkali aggregate reactivity
- Petrography examination
- Deleterious materials and organic impurities
- Test for aggregate crushing value

Any or all these tests would normally be ordered to be carried out only if the Engineer feels the materials are not obtained and shall be performed by the contractor at an approved test laboratory The contractor shall bear the charges of these optional tests.

Concrete not made to the requirements of specification in all respects may be rejected by the Engineer-in-Charge in which case it shall be removed and reconstructed entirely at the expense of the contractor.

5.10.1 Load test on Members or any other tests

i. In the event of any work being suspected of material or workmanship or both, the Engineer-in-charge requiring its removal and reconstruction may order, or the contractor may request that it should be load tested in accordance with the following provisions.
ii. The test load shall be 125% of the maximum superimposed load for which the structure was designed. Such test load shall not be applied before 56 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.
iii. If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75% of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 75% of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer-in-Charge, the cost of all the new construction and the load tests shall be borne by the contractor.
iv. Any other tests, e.g. taking out in an approved manner concrete cores, examination and tests on such cores removed from such parts of the structure as directed by the Engineer-in-charge, sonic testing etc. shall be carried out by the contractor, if so directed, at no extra cost.

5.10.2 Unsatisfactory tests

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, the contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by the Engineer-in-Charge.

5.11 ADMIXTURES

5.11.1 General

Admixtures may be used in concrete where required, only with the approval of the Engineer-in-Charge. How ever it should be seen that, with the passage of time, neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1.5% of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instruction and in the manner and with the control specified by the Engineer-in-Charge.

5.11.2 Air Entraining Agents

Neutralized vinson resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

5.11.3 Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Engineer-in-charge. The admixtures shall be added in the form of a solution.

5.11.4 Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Engineer-in-Charge.

5.11.5 Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

5.11.6 Other Admixtures

The Engineer-in-Charge may at his discretion allow the contractor to use any other admixture in the concrete.

5.12 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

a. Before the concrete is actually placed in position, the insides of the Formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottoms of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be suitably plugged later.
b. The various agencies shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedment to be cast in the concrete as specified or required or as is necessary for the proper execution of the work as specified in the drawings.
c. All embedded parts, inserts, etc. supplied by the PHED or the contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.
d. All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Engineer-in-charge.
e. Slots, openings, holes, pockets etc. shall be provided in the concrete work in the position specified in drawing or required or as directed by the Engineer-in-charge.
f. Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.
g. Prior to concrete placement, all work shall be inspected and approved by the Engineer-in-Charge and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected.
h. Approval by the Engineer-in-Charge of any and all materials and work as required herein shall not relieve the contractor from his obligation to produce finished concrete in accordance with the requirements of the specifications.
i. Rain or wash water: No concrete shall be placed in wet weather or on a water-covered surface. Any concrete that has been washed by heavy rains shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage, which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided. During summer season, temperature of water should be maintained, as per the criteria and for the same, icing should be done for concreting work.
j. Bonding Mortar: Immediately before concrete placement begins, prepared surfaces except Formwork, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified.

k. The corrosive matters on the reinforcement should be removed by means of wire brush.
l. Laitance should be removed by means of chiseling from top concrete layer which was earlier concreted.

5.13 TRANSPORTATION

5.13.1 General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight, leak proof irrespective of the method of transportation adopted; concrete shall be delivered with the required consistency and plasticity without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-charge and concrete shall not be re-handled before placing.

5.13.2 Retempered or Contaminated Concrete

Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing. Concrete, which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by the Engineer-in-Charge.

5.13.3 Avoiding Segregation

Concrete shall, in all cases, be deposited as nearly as practicable directly, in its final position and shall not be re-handled to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded insets, or impair its strength. For locations where direct placement is not possible, and in narrow forms, the Contractor shall provide suitable drop and “Elephant Trunks” to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in column and the walls.

5.13.4 Placing by Manual Labour

Except when otherwise approved by the Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements, and shall not be dropped from a height more than 1.0 m or handled in a manner, which will cause segregation.

5.13.5 Placing by Mechanical Equipment

The following specification shall apply when placing concrete by use of mechanical equipment is warranted considering the nature of work involved. The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

5.13.6 Types of Buckets

Central-bottom-dump buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete in all

dumping positions, shall be employed. In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner, which results in separation of ingredients or disturbance of previously placed concrete, will not be permitted.

5.13.7 Placement of Restricted Forms

Concrete placed in restricted forms by barrows, buggles, cars, short chutes or hand shoveling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

5.13.8 Chuting

Where it is necessary to use transfer chutes, specific approval of Engineer-in-charge must be obtained to type, length slopes, baffles, vertical terminals and timing of operations. These shall be so arranged that an almost continuous flow of concrete be obtained at the discharge and without segregation. Concrete should flow smoothly in the chute and there should not be any obstruction to the flow. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the wastewater shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use shall have slopes not flatter than 1 vertical, 3 horizontal and not steeper than 1 vertical, 2 horizontal. Chutes shall be of metal or metal lines end of rounded cross section. The slopes of all chute sections shall be approximately the same. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

5.13.9 Placing by Pumping/Pneumatic Placers

Concrete may be conveyed and placed by mechanically operated equipment e.g., pumps or pneumatic placers only with the written permission of the Engineer-in-Charge at no extra cost. The slump shall be held to the minimum necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipeline shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. Care shall be taken to avoid stoppages in work once pumping has started.

When a pneumatic placer is used, the manufacturer’s advice on layout of the pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end. Manufacturer’s recommendations shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipment is used. It should be noted that no extra payment is made for these items, if required and directed by Engineer-in-Charge.

5.13.10 Concrete in layers

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm to 45 cm directed by Engineer-in-Charge. These shall be placed as rapidly practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer-in-charge.

5.13.11 Cover Blocks

Cover blocks of required size depending on the cover of the reinforcement as mentioned in the
drawings should be prepared in 1:3 cement mortar with fine aggregates.

5.13.12 Bedding of layers

The top surface of each pour and bedding planes shall be approximately horizontal unless
otherwise instructed. Top layer should be rough and with key for further extension of work.

5.13.13 Compaction

Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point those segregation results.

5.13.13.1 Type of vibrators

Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

5.13.13.2 Use of Vibrators

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention be paid to vibration at the top of a lift e.g. in a column or wall.

5.13.13.3 Melding Successive Batches

When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration blending and melding of the concrete between the succeeding layers.

5.13.13.4 Penetration of Vibrators

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

5.13.13.5 Vibrating against Reinforcement

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

5.13.13.6 Use of Form Attached Vibrators

Form attached vibrators shall be used only with specific authorization of the Engineer-in-Charge.

5.13.13.7 Use of surface vibrators

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, surface vibrating by specially designed vibrators may be permitted, upon approval of Engineer-in-charge.

5.13.13.8 Stone Pockets And Mortar Pondages

The formation of stone pockets and mortar pondages in corners and against faces of forms shall not be permitted. Incase of these occur, they should be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by the Engineer-in-charge.

5.13.14 Placement Interval

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for atleast 24 hours after the final set of concrete and before the start of a subsequent placement.

5.13.15 Special Provision in Placing

When placing concrete in walls with openings, in floors of integral slabs and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be.Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by the Engineer-in-Charge.

5.13.16 Placing Concrete Through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to obtain Engineer in-Charge's permission for temporarily moving the top steel aside for proper placement & for restoring reinforcement as per drawing.

5.13.17 Bleeding

Bleeding or free water on top of concrete being deposited into the forms, shall be the cause to stop the concrete pour and the conditions causing this defect corrected before any further Concreting is resumed.

5.14 APPLICATION OF ARALDITE FOR BONDING OF NEW AND OLD CONCRETE

5.14.1 General

Araldite epoxy resins will be used to bond fresh concrete to concrete that is fully cured, to give a monolithic bond capable of transmitting high stresses when traditional bonding agents such as cement slurry cannot always be relied upon to provide good adhesion which is particularly the case when large areas are involved.

a. The Araldite based formulation shall be applied to suitably prepared concrete sub-strata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive.
b. Materials used shall be of best quality and approved by the Engineer-in-charge.
c. Manufacturer's instructions shall be followed in all respects.
d. No separate payment shall be paid for this item of work.

5.14.2 Formulation

Araldite GY250	100	Parts by weight
Hardener HY825	20	Parts by weight
Hardener HY830	20	Parts by weight
Hardener HY850	20	Parts by weight
Silica Flour	20	Parts by weight

5.14.3 Application

5.14.3.1 Preparation of the Substrata

To obtain good adhesion, it is necessary to have clean and sound substrata. Preparation can be carried out using a variety of techniques including chemical treatment and mechanical methods such as grinding, milling, abrading, planing and sand blasting. Dust and loose particles resulting from the pretreatment should be removed by vacuum cleaning or oil-free or blast.

5.14.3.2 Mixing

The resin and hardener should be thoroughly mixed in the dry filler. The mixed, ready to use adhesive should not contain lumps of unwetted filler and should be of uniform color. For a total weight of 1 kg or less hand mixing should be sufficient. For quantities in excess of 1 kg, the use of a mechanical mixer is recommended

5.14.3.3 Pot life and 'Open time'

The pot life is the period during which the ready to use ARALDITE based formulation must be applied. After this period, the mix can no longer be worked and will have begun to set in its container. The table below indicates the pot life at different temperatures:
(The figures in this table are for batches less than 1 kilogram).
The 'Open time' is the maximum period of time allowable between application of the ARALDITE adhesive and pouring the fresh concrete. Exceeding the 'Open time' would result in considerably reduced adhesion. The adhesive should be applied to the pre-treated substrata as soon as the components have been mixed and fresh concrete poured immediately afterwards.
Accurate knowledge of the 'Open time' is essential in case the work is interrupted.

Table gives the 'Open time' of ARALDITE based formulations as a function of substrata temperature. In all cases, the adhesives shall be applied immediately after mixing. Any delay between mixing and application will reduce the 'Open time'. Fresh concrete must be poured before the adhesive begins to gel. New to old concrete bonding is not recommended at temperatures below 5°C, as curing cannot be assured under these circumstances.

5.14.3.4 Methods of Application

The shape and size of the concrete structure will determine the method of application used. The ARALDITE based adhesive may be applied by hand using brushed, brooms or any other suitable applicator.

5.14.3.5 Suitability of Fresh Concrete

Best results are obtained when the water/ cement ratio of the new concrete is low as is practicable.

Mix Temperature (Degree Celsius)	**Pot Life (minutes)**
25	90
30	60

5.14.3.6 Coverage

One kilogram of the mixed ARALDITE adhesive including hardeners and filler covers an area of 2 to 3 sq.m. when applied with a stiff nylon bristle brush. However, the coverage is very much dependent on the finish in the concrete.

5.15 HANDLING PRECAUTIONS

Epoxy resins can cause irritation of the skin in sensitive person if incorrectly handled. Certain safety precautions must therefore be observed and those handling the resins and hardeners should be given suitable instructions. Those working with epoxy resins should, above all, be instructed that personal cleanliness at the place of work is essential. The resin and hardener should not be allowed to come into direct contact with the skin. The most effective protection is achieved by wearing rubber or polythene gloves, the latter having the advantage that they can be replaced when dirty. They are more pleasant to wear if cotton gloves are worn underneath. Parts of the skins, which have come into contact with the resin or hardener, should be washed with lukewarm water and a mild soap. Special cleaning creams may be used as they have proved to be highly suitable.

5.16 CONSTRUCTION JOINTS

a. A construction joint is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken to achieve subsequent continuity without provision for further relative movement.
b. No concreting shall be started until the Engineer-in-Charge has approved the method of placing the positions and form of the construction joints and lifts. The construction joints shall be so located as not to impair the strength of the structure. Water stops shall be inserted as per clause 5.18
c. Concrete placed to form the face of a construction joint shall have all Laitance removed and the aggregate exposed prior to the placing of fresh concrete. The Laitance shall wherever practicable be removed by spraying the concrete where it is still green. The whole of the concrete surface forming part of the joint shall be hacked to expose the aggregate. Where aggregate is damaged during hacking, it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blasting or washing, leaving the surface clean and damp. Immediately before fresh concrete is placed, a 12 mm thick layer of

sand/cement mortar mixed in the same proportions as in the concrete shall be spread in the horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid Laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

5.17 MOVEMENT JOINTS

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Engineer-in-Charge, demonstrate that the jointing materials can be applied satisfactorily.
2. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.
3. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer’s instructions. At all caulked joints, the face of the caulking strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

5.18 WATER STOPS AND JOINT FILLERS

5.18.1 Water stops

a. At all construction, contraction and expansion joints in the water retaining structures and wherever specified or directed by the Engineer-in-Charge, water stops shall be provided. The water stops shall be PVC type or of any other equivalent material as approved by the Engineer-in-Charge. PVC water stops shall have a tensile strength of not less than 14 MN/sq.m and elongation at break of not less than 300%. Water stops shall not be exposed to direct sunlight for long periods. Before being concreted in water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.
b. As far as possible, jointing on site shall be confined to the making of butt joints in straight runs of water stops and all the joints should be monolithic. Where it is agreed with the Engineer-in-charge that it is necessary to make an intersection or change of direction of any joint, other than a butt joint in a straight run on site, a preliminary joint, intersection or change of direction piece shall be made and submitted to such tests as the Engineer-in-charge may require.

c. Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.
d. The different types of water stops to be used in liquid retaining structures will be as per "
e. Table 9 : Types of Water Stops".
a. Table 9 : Types of Water Stops

Sr. Type of Joint Type of water stops

1. Partial/complete contraction joint in walls and slabs
2. Expansion joints in walls and slabs

S.No.	Type of Joint	Type of water stops
1	Construction joint in raft	230 mm wide, ribbed with hollow centre bulb & 6 mm minimum thickness
2	Construction joint in wall	230 mm wide, ribbed with hollow centre bulb & 6 mm minimum thickness
3	Expansion joint raft	230 mm wide, ribbed with hollow centre bulb & 6 mm minimum thickness

5.18.2 Jointing fillers

Joint fillers shall be of durable, compressible and non-extruding material.

5.19 SEALING COMPOUNDS

Horizontal joints shall, where used in water-retaining structures be sealed with a cold pouring polysulphide rubber sealing compound of quality equal to, or better than serviced "Paraseal". Horizontal joints in roofs, floors and other non-water retaining structures shall be sealed with an approved sealant with properties equal to or better than serviced "Paraplastic 41". Vertical joints and joints in the soffits of slabs in both water retaining as well as non-water retaining structures shall be sealed with a trowel or gun applied polysulphide rubber sealing compound such as serviced "Vertiseal" or equivalent. Sealing compounds shall be fully cured before water is permitted to come in contact. At 40 C, the curing time would be approximately 7 weeks for polysulphide compound.

5.20 TOLERANCES IN CONCRETE SURFACES

- Concrete surfaces for the various classes of unformed and formed finishes specified in various clauses shall comply with the tolerances shown in Table hereunder, except where different tolerances are expressly required by the specification.
- In the table 'line and level' and 'dimension' shall mean the lines, levels and cross-sectional dimensions as specified and required.
- Surface irregularities shall be classified as 'abrupt' or 'gradual'. Abrupt irregularities include by shall not be limited to offsets and fins caused by displaced or misplaced formwork, loose knots and

other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plane surfaces and 1.5 m long formed surfaces.

Class of Finish	Maximum tolerance (mm) in:			
	Line & level	Abrupt	Gradual irregularity	Dimension
U1	12	6	6	-
U2	6	3	3	-
U3	6	3	3	-
F1	12	6	6	+12-6
F2	6	6	6	+12-6

5.21 CURING, PROTECTING, REPAIRING AND FINISHING

5.21.1 Curing

All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

5.21.2 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

5.21.3 Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer-in-charge.

5.21.4 Alternate Curing Methods

Whenever in the judgment of the Engineer-in-charge, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in sidewalks, floors, flat roofs of

other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-in-charge. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

5.21.5 Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer-in-Charge. Curing compounds shall be liquid type white pigmented, conforming to US Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified.

5.21.6 Curing Equipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

5.21.7 Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineer-in-Charge shall also be taken to protect immature concrete from damage by debris, excessive lading, vibration, abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer-in-Charge may require that bridges be placed over the area.

5.21.8 Repair and Replacement of Unsatisfactory Concrete

5.21.8.1 General

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of the Engineer-in-charge who may permit patching of the defective areas or also reject the concrete unit either partially or in its entirety. Rejected concrete shall be removed and replaced by the contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer-in-charge. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer-in-charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer-in-charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other

irregularities, care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer-in-charge shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

5.21.8.2 Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Engineer-in-charge. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

5.21.8.3 Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer-in-charge, to match the shade of the patch with the original concrete.

5.21.8.4 Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

5.21.8.5 Approval by the Engineer-in-Charge

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer-in-Charge.

5.21.9 Finishing

5.21.9.1 General

The type of finish for formed concrete surfaces shall be as follows, unless varied by the Engineer-

in-Charge.

When the structure is in service all the surfaces shall receive no special finish, except repair of damaged or defective concrete, removal of fine and abrupt irregularities, filling defective concrete, filling of holes left by form ties and rods and clean up of loose or adhering debris. Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless a horizontal surface or the slope required is specified, the tops of narrow surfaces such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surfaces such as walkways, and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, subfloors to be covered with concrete topping, terrazzo or quarry tiles and similar surfaces shall be smooth ascended and leveled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside decks, floors of galleries and sumps, parapets, gutters, side-walks, floors and slabs, shall be consolidated, screened and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as specified or as directed by the Engineer-in-Charge.

5.21.9.2 Standard Finish For Exposed Concrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the works. Unless otherwise specified, the standard finish for exposed concrete shall be a smooth finish. A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels of forms shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothed off and all blemishes, protections etc., removed leaving the surfaces smooth.

5.21.9.3 Integral cement concrete finish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by the Engineer-in-charge. The surface shall be tested with a straight edge and any high and low spots

eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

5.21.9.4 Rubbed finish

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundun or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

5.21.9.5 Protection

All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

5.22 HOT WEATHER REQUIREMENT

a. All concrete work performed in hot weather shall be in accordance with IS: 456, except as herein modified.
b. Admixtures may be used only when approved by the Engineer-in-Charge.
c. Adequate provisions shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 degrees centigrade.
d. Consideration shall be given to shading aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available, and burying, insulating, shading and/or painting white the pipelines and water storage tanks and conveyance.
e. In order to reduce loss of mixing water, the aggregate, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting, placement and finishing shall be done as quickly as possible.
f. Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

5.23 PLACING CONCRETE UNDERWATER

a. Under all ordinary conditions, all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS: 456 and the procedure shall be as follows:

- **Method of Placement**: Concrete shall be deposited underwater by means of tremises, or drop bottom buckets of approved type.
- **Direction, Inspection and Approval**: All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to specifications approved by the Engineer-in-Charge.

b. Special precautions shall be taken for prevention of lifting of concrete due to uplift pressure of subsoil water.

5.24 PRECAST CONCRETE

5.24.1 General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

5.24.2 Striking Forms

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

5.24.3 Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy the Engineer-in-charge or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

5.24.4 Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

5.25 SLOTS, OPENINGS, ETC.

5.25.1 General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by Engineer-in-charge. Short pipes with puddle collar shall be fixed in the sidewall of suction pipes. They shall be supplied at the appropriate time during construction. Any deviation from the approved drawings shall be made good by contractor at own expense, without damaging any other work.

Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

5.25.2 Grouting

5.25.2.1 Standard Grout

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as per "*Table 10: Proportions for Standard Grout*".

Table 10: Proportions for Standard Grout

S.No.	Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
1	Fluid	Under 25 mm	One part Portland cement	0.44
2	General	25 mm & over but less than 50 mm	One part Portland cement to 2 parts of sand	0.53
3	Stiff Mix	50 mm & over	One part Portland cement to 3 parts of sand	0.53

Sand shall be such as to produce a flowable grout without any tendency to segregate. Sand for general grouting purposes, shall be graded within the following limits:

- Passing 2.36 mm sieve 95 to 100%
- Passing 1.18 mm sieve 65 to
- Passing 300 micron 10 to
- Passing 150 micron 3 to 10%

Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above. Sand, for still grouts, shall meet the usual grading specifications for concrete laitance. Anchor bolts, anchor bolt holes and the bottoms of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started. Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place. Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release trapped air, link chains can be used to work the grout into place. Grout throughout holes in base plates shall be by pressure

grouting. Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-charge.

5.25.2.2 Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as per "*Table 11: Proportions for Non-Shrinking Grout*".

Table 11: Proportions for Non-Shrinking Grout

S.No.	**Properties**	**Values**
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout	2.27 – 2.30 gm/m
4	Compressive strength N/sqmm	
	- Minimum 3 days	23
	- 7 days	34

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions.

5.26 INSPECTION

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer-in-Charge.
b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
c. All concrete shall be protected against damage until final acceptance by the Engineer-in-Charge.

5.27 CLEAN-UP

a. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
b. All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer-in-Charge.
c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer-in-Charge.

5.28 RECORDS OF CONCRETING

An accurate and up to date record showing times, dates, weather and temperature conditions when various positions of all the concrete structures forming the works were concreted will be kept by the Engineer-in-charge and shall be countersigned by the Contractor. If

the Contractor fails to sign the Engineer-in-Charge's record; it shall nevertheless be regarded as correct and binding on the Contractor.

The Contractor has to submit concrete pour card in duplicate duly to be signed to the Engineer-in-Charge for each type of concreting work. Contractor shall keep copy of it, after Engineer-in-Charge has checked and signed the pour card.

5.29 SUPPLY OF CEMENT

Contractor shall procure / purchase the cement and shall be stacked and well maintained as specified in the earlier sections. Contractor shall procure cement in those quantities required for maximum one month of concreting work and more than the prescribed time limit is not allowed. For any damage to cement, PHED will not be responsible and the damaged cement will not be used in the work.

5.30 FOUNDATION BEDDING, BONDING AND JOINTING

a. All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering, as specified or as the Engineer-in-charge may direct, to meet the various situations encountered in the work.
b. Soft or spongy areas shall be cleaned out and backfilled with lean concrete or clean sand fill compacted.
c. Prior to construction of formwork for any item where soil will act as bottom form, approval shall be obtained from the Engineer-in-Charge for the suitability of the soil.

5.31 PREPARATION OF ROCK STRATA OF FOUNDATIONS

a. To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.
b. Concrete shall not be deposited on large sloping rock surfaces. Where required by the Engineer-in-charge, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.
c. Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.
d. Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.
e. Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.
f. Before placing concrete on rock surfaces all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

End of Chapter 5

CHAPTER-6

FORMWORK

6.1 FIXING OF FORMWORK

All formwork shall be constructed of plywood or sheet metal Plywood used for form work shall be conforming to IS:4990i.e Specification for plywood for concrete shuttering works. The materials for form work shall got approved by the Engineer before starting the work. Form work shall be firmly supported, adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffits of beams other than prestressed beams shall in the absence of any specified camber, be erected with an upward camber of 6 mm for each 3 meters of span.

The Contractor shall be responsible for the calculations and designs for the formwork, and if required, shall submit them to the Engineer for approval before construction on formwork to external faces which will be permanently exposed, all horizontal and vertical formwork joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the formwork for standard sized manufactured formwork panels, the size of such panels shall be approved by the Engineer before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining

structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joint to ensure continuity of horizontal and vertical lines. Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter. Joints shall be sufficiently watertight to prevent the escape of mortar or the formation of fins or other blemishes on the face of the concrete.

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation, care being taken to prevent air being trapped.

Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete. Before placing concrete, all bolts, pipes or conduits or other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without approval of the Engineer.

All exterior angles on the finished concrete of 90 degree or less shall be given 20 mm x 20 mm chamfers unless otherwise ordered by the Engineer.

No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concrete and 150 mm in the case of un-reinforced concrete. Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.

Formwork in contact with the concrete shall be treated with a suitable non-staining mould oil to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Engineer.

6.2 REMOVAL OF FORMWORK

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the

Engineer, remove the formwork at the earlier times listed below provided that the props are left in position.

TABLE 6.1

Position of Formwork	**Days for Striking**
Walls	1
Sides of beams and columns	1
Slabs (Drops left under)	3
Props to slabs (span not exceeding 4.5m)	7
Props to slabs (span exceeding 4.5 m)	14
Beams soffits (props left under)	21

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the form work it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by the Engineer, to facilitate removal of formwork which otherwise may be inaccessible.

The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

For liquid retaining structures, no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall be cut at 25 mm depth or more from the surface and then the hole shall be made good by cement sand mortar of the same proportions as the concrete just after striking the formwork.

6.3 FORMED SURFACES – CLASSES OF FINISH

Finishes to formed surfaces of concrete shall be classified as F1, F2, or F3, or such other special finish as may be particularly specified. Where the class of finish is not specified the concrete shall be finished to Class F1.

Formwork for Class F3 finish shall be lined with as large panels as possible of non-staining material with a smooth unblemished surface such as sanded plywood or hard compressed fibre board, arranged in a uniform approved pattern and fixed to back formwork by oval nails. Unfaced wrought boarding or standard steel panels shall not be permitted.

Formwork for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

Formwork for Class F1 finish shall be constructed in sheet metal. Surfaces subsequently to be rendered, plastered or tiled shall be adequately scrabbled or hacked as soon as the formwork is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

6.4 DIFFECTS IN FORMED SURFACES

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surfaces being perfectly compacted and smooth.

If any blemishes are revealed after removal of formwork, the Engineer's decisions concerning remedial measures shall be obtained immediately. These measures may include, but shall not be limited to the following:

i) Fins, pinhole bubbles, surface dis-coloration and minor defects may be rubbed down with sacking immediately after the formwork is removed.

ii) Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured. These and any other defects shall be remedied by methods approved by the Engineer which may include using a suitable epoxy resin or, where necessary, cutting out to a regular dovetails shape at least 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.

6.5 HOLES TO BE FILLED

Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary Portland cement and three parts fine aggregate passing IS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

The contractor shall thoroughly clean any hole that is to be filled with dry-pack mortar and where the surface has been damaged, the contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted

lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact

With the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.

The dry-pack material shall then be placed and packed in layers having a compacted thickness not greater then 15 mm. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction, the surface of each layer shall be scratched the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

6.6 TOLERANCES

Tolerance is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for RCC Structures

i) Variation from the plumb
   a) In the lines and surfaces of columns, piers, walls 5 mm per 2.5 m or 25 mm, whichever is less.
   b) For exposed corner columns and other conspicuous lines
      In any bay or 5 m maximum 5 mm
      In 10 m or more 10 mm

ii) Variation from the level or from the grades indicated on the approved drawings
   a) In slab soffits, ceilings, beam soffit, and in arises
      In 2.5 m 5 mm
      In any bay or 5 m maximum 10 mm
      In 10 m or more 15 mm
   b) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines
      In any bay or 5 m maximum 5 mm
      In 10 m or more 10 mm

iii) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions
   In any bay or 5 m maximum 10 mm
   In 10 m or more 20 mm

iv) Variation in the sizes and locations of sleeves, openings in walls and floors

Except in the case of and for anchor bolts	5	mm

v) Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus	5 mm
Plus	10 mm

vi) Footings

a) Variation in dimension in plan

Minus	5 mm
Plus	10 mm

b) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

c) Reduction in thickness

Minus 5% of specified thickness subject to a maximum of 50 mm

vii) Variation in steps

a) In a flight of stairs

Rise	3 mm
Tread	5 mm

b) In consecutive steps

Rise	1.5 mm	
Tread	3	mm

Tolerances in other Concrete Structures

viii) All structures

a) Variation of the constructed linear outlines from established position in plan

In 5 m	10 mm
In 10 m or more	15 mm

b) Variations of dimensions to individual structural features from established positions

In 20 m or more	25 mm
In buried construction	50 mm

c) Variation from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m	10 mm
In 5 m	15 mm
In 10 m or more	25 mm
In buried construction	Twice the above amounts

d) Variation from level or grade indicated on approved drawings in slab, beams, soffits, horizontal grooves and visible arises

In 2.5 m	5 mm
In 7.5 m or more	10 mm
In buried construction	Twice the above amounts

e) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members

Minus	5 mm
Plus	10 mm

ix) Footings for columns, piers, walls, buttresses and similar members

a) Variation of dimensions in plan

Minus	10 mm
Plus	50 mm

b) Misplacement or eccentricity
2% of footing width in the direction of misplacement but not more than 50 mm.

c) Reduction in thickness
5% of specified thickness subject to a maximum of 50 mm

x) Tolerance in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Formwork (American Concrete Institute Act 347).

xi) Tolerance in fixing anchor bolts shall be as follows:

a)	Anchor bolts without sleeves	+ 5 mm
b)	Anchor bolts with sleeves	+ 5 mm for bolts up to 20 mm dia + 3 mm for bolts above 32 mm dia
c)	Embedded parts	+ 5 mm in all directions

6.7 BRACING, STRUTS AND PROPS

Formwork shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bearers.

The formwork for beams and slabs shall be so erected that the formwork on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be done except when props have to be reinstated to take car of construction loads anticipated being in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the formwork.

If the formwork for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of the concrete proceeds, or windows may be left for pouring concrete from

the sides to limit the drop of concrete to 1.0 m as directed by the Engineer.

6.8 TECHNICAL SPECIFICATIONS FOR SHEET PILING

6.8.1 GENERAL

Sheet piling is a form of driven piling using interlocking sheets of steel to obtain a
continuous barrier in the ground. The main application of sheet pile is in retaining
walls erected for the purpose of excavation to enable permanent works to proceed. Normally vibrating hammer/ impact hammer, crane and crawler drilling are to be used to establish sheet piles.
The work shall include supply, installation and subsequent removal of all
miscellaneous steel shapes, plates and connecting hardware when required to
attach the sheeting to an existing substructure unit and/or facilitate stage
construction.

All initial banking has to be formed at contractor's own cost for taking the machinery to drive the sheet piles. The area shall be filled driving of steel sheet piles with pit sand for leveling the ground.

Piles shall be driven, true to plumb and alignment. Hammer for sheet pile driving shall be drop hammer, steam hammer, air hammer, diesel hammer or vibratory hammer. Sheet pile driving shall commence initially with minimum impact of hammer, which can be increased later after ensuring that the piles are being driven vertically through the interlocking grooves along with designed alignment. The sheet piles are to be driven with batten welded at suitable intervals. The Steel Sheet Pile may be lifted at single point.

6.8.2 APPLICABLE CODE

All work shall be carried out strictly in accordance with the Technical Specifications,

unless otherwise approved by Engineer-In-Charge in writing. The Indian Standard

Codes applicable to this section shall include but not limited to the following.

INDIAN STANDARDS (IS CODES)

IS 2314:1986 Specification for steel sheet piling sections (first revision)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M (2000) General Requirements for Rolled Structural Steel Bars,

Plates, Shapes, and Sheet Piling

ASTM A 328/A 328M (200) Steel Sheet Piling

ASTM A 572/A 572M (200) High-Strength Low-Alloy Columbium-Vanadium

Structural Steel

ASTM A 690/A 690M (1994) High-Strength Low-Alloy Steel H-Piles and

Sheet Piling for Use in Marine Environments

ASTM A 857/A 857M (1997el) Steel Sheet Piling, Cold Formed, Light Gage.

6.8.3 TRANSPORTATION:

The Contractor shall set up, in accordance with the construction schedule make all the necessary arrangements for hauling of all materials for the steel sheet pile driving so that all the materials will be available for immediate use whenever required:

a) All the steel sheet piles shall be delivered intact at the site without causing any permanent distortion in the member or injury or deformation at joints.

b) Care shall be taken in handling such materials as tie-rods to avoid damage to the thread and shop coat painting.

c) Handling of such long members as walling shall be carried out in the same way as for the steel sheet piles.

6.8.4 STORAGE:

a) Storage space for steel sheet piles shall be reasonably leveled and compacted. The site so selected should be got approved by the ENGINEER.

b) Steel sheet piles shall be stacked in such a way as to avoid strain or distortion in the materials.

c) Steel sheet piles shall be stacked up in such tiers as each consisting of not more than 3 piles, and between each tier wooden sleepers shall be inserted at intervals not exceeding 4m. Total height of stack shall not exceed 2m.

d) Tie-rods and accessories shall be sorted, stacked in accordance with their diameters and shall be stored under cover and not be directly exposed to weather.

e) The Contractor shall be responsible for safe handling, mobilization & demobilization and storage of piles and other materials. The rate for sheet pile driving shall include the cost for handling and storage of piles and other accessories, forming driving pit, formation and removal of earthen bund if required, all other requisites for successful driving of sheet pile.

6.8.5 CUTTING OF SHEET PILE:

a) Cutting of steel sheet piles shall be done by means of a gas cutting device.

b) Steel sheet piles to be cut shall be free from curve and warp, and securely clamped on a level work table for cutting.

c) Use of a special jig is desirable to minimize deformation due to cutting

d) Whatever method is used in cutting, a certain degree of deformation is bound to occur. If the deformation is less than 40mm, it can be set right by hammering or by heat treatment to the deformed segment. If the deformation exceeds the above range, mechanical correction by means of jacks and press shall be made.

6.8.6 SHEET PILE WELDING:

a) Arc welding shall be adopted for steel sheet pile work.

b) Only skilled welders approved by the ENGINEER shall be engaged for the work.

c) Welding equipment shall be AC rectifiers / arc-welding unit. Welding rods shall be those conforming to the relevant IS or equivalent and subject to prior approval of ENGINEER.

d) If any welding is rejected by the ENGINEER, the Contractor shall perform the welding again by cutting off at the weld at his cost. All the costs thereof shall be borne by the Contractor.

6.8.7 MATERIALS

Metal sheet piling material shall be conforming to IS -2314 or equivalent ASTM standards.The interlocks of sheet piling shall be free-sliding, provide a swing angle
suitable for the intended installation but not less than 5 degrees when interlocked,
and maintain continuous interlocking when installed. Sheet piling [including special

abricated sections] shall be [full-length] sections of the dimensions as shown in the drawing. Sheet piling shall be provided with standard pulling holes.

Metal plates, shapes, bolts, nuts, rivets, and other appurtenant fabrication and
installation materials shall conform to manufacturer's standards and to the
requirements specified in the respective sheet piling.

6.8.8 EXTRACTION OF REJECTED SHEET PILE:

If the pile driving work has not been done to the specification, the Contractor shall extract the rejected pile. The extraction shall be such as to avoid damages to the adjoining piles, other structures and installations. Cost of extraction and replacement shall be borne by the Contractor.

6.8.9 CONSTRUCTION

The Contractor shall verify locations of all underground utilities before driving any sheet piling. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor’s operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additional cost to the Department. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor’s approved design. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor’s approved design. The sheet piling shall be driven, as a minimum, to the tip elevation(s) specified, prior to commencing any related excavation. If unable to reach the minimum tip elevation, the adequacy of the sheet piling design will require re-evaluation by the PMC/ Owner prior to allowing excavation adjacent to the sheet piling in question. The Contractor shall not excavate below the maximum excavation line shown on the plans without the prior permission of the Engineer. The sheet piling shall remain in place until the Engineer determines it is no longer required.

The sheet piling shall be removed and take away from site by the Contractor when directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the sheet piling leaving the rest in place. The remaining piling shall be a minimum of 12 in. (300 mm) below the finished grade or as directed by the Engineer. Removed sheet piling becomes the property of the Contractor. When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to,

boulders, logs, old foundations etc.) where it's presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven through or around with normal driving procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

The following are the installation procedure:-

1 The alignment of sheet pile wall shall be correctly set up for the approval of the ENGINEER before commencing the sheet pile driving.

2 Guide frames and stakes shall be installed correctly and secured properly to ensure driving of piles on the centre line.

3 Steel sheet pile driving shall be performed by one of the following methods:

a) In driving single pile one by one, special care shall be exercised to keep each pile penetrating in strictly vertical direction.

b) In driving a group of piles (about 20 pieces simultaneously) a guide frame shall be used to keep them in a straight alignment, and in the initial stage all the piles shall be driven to a depth just enough to enable them to stand in positions. Then one or two pieces on both ends shall be driven down first, followed by the intermediate piles which shall be driven alternately in several stages to final level.

4 Hammer for steel sheet piling shall be drop hammer, steam hammer, air-hammer, diesel hammer, electric vibratory hammer and vibro-hammer. Before employing a driving hammer, Contractor shall obtain approval of the ENGINEER for its use in the job.

5 Prior to starting pile driving, the Contractor shall submit the driving method and time schedule for approval of the ENGINEER and in accordance with the sequence approved by the ENGINEER. The piles shall be driven vertically in the specified positions.

6 Pile driving:

6.1 Sheet pile driving shall commence initially with minimum impact of hammer and increased later after ensuring that the piles are being driven vertically in designed alignment.

6.2 Pile shall be driven with cap and cushion on top of the pile for protection against the impact of drop hammer.

6.3 Lengthening of pile, if required, shall be done by welding additional piece on to the top of pile already driven. The joints shall be as strong as the normal section of the pile.

6.4 In case interlocks of piles with adjacent ones are found loosened or dislocated during or after driving, such piles shall be pulled out and replaced with new ones or redone otherwise in accordance with instructions of the ENGINEER.

6.5 The Contractor shall take every step to ensure safety and to prevent accident while handling and driving piles. If any deviation from specified lines, fractured top, deficient or excessive penetration is observed during pile driving, the driving shall be suspended to take corrective measures as directed by the ENGINEER.

6.6 Necessary data and logs such as of the number of blows, length of penetration etc. during sheet pile driving shall be made and submitted in duplicate to the ENGINEER at no extra cost. Format of driving log shall be got approved by ENGINEER prior to commencement of driving sheet piles

7 Reformed steel sheet piles:

7.1 Reformed steel sheet piles shall be of three types, namely corner sheet pile, junction sheet pile and wedge sheet pile.

7.2 Corner sheet piles are used where centre line for driving turns to form an angle, and joined by welding to the sheet pile wall that has changed its direction.

7.3 Junction sheet piles are those to be used where two walls of sheet piles meet at right angle forming a T junction, and where the sizes of sheet pile change along the same line.

7.4 Wedge sheet piles are used to make up for the deviation of piles from the plumb line caused during driving. This type of pile is characterized by its wedge like shape, tapering downward to the tip.

7.5 Reformed steel sheet piles as mentioned above shall as a rule is manufactured in a factory. If it becomes inevitable to fabricate them in the field at site, the Contractor shall provide equipment and manufacturing means equivalent to those of the regular factory production and have close supervision and control over driving.

7.6 If the Contractor finds it necessary to use the reformed steel sheet piles, he shall obtain approval of the ENGINEER for the use, and fabricate the same at his own cost in accordance with the instructions of the ENGINEER.

6.8.10 PAYMENT FOR STEEL SHEET PILING:

The Contractor shall be paid for the net area of the steel sheet piles actually driven in the work in accordance with the Contract drawings or as directed by the ENGINEER. The unit rate for steel sheet pile driving shall include the costs of material, transportation, driving and incidental costs towards replacement of the damaged steel sheet piles. The cost will also include the cost of waling and accessories. While paying the unit cost under this item, deduction of 10% of the unit rate under sub-item of Sl no 1 of BOQ, (Earthwork) will be made towards Shoring and Strutting provision made in the relevant excavation sub items which is analyzed based on the practical experience and rate analysis of excavation of trench

End of Chapter 6

CHAPTER-7

REINFORCEMENT

7.1 GENERAL

Reinforcement shall be Thermo Mechanically Treated Fe 500 Bars as per IS: 1786. Wire mesh or fabric shall be in accordance with IS:1566.

Substitution of reinforcement will not be permitted except upon written approval from the Engineer.

7.2 STORAGE

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the Engineer.

Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

7.3 QUALITY

No re-rolled material will be accepted. If requested by the Engineer, the contractor shall submit the manufacturer's test certificate for the steel. Random tests on steel supplied by the contractor may be performed by the Engineer as per relevant Indian Standards. All costs incidental to such tests shall be at the contractor's expenses. Steel not conforming to specifications shall be rejected.

All reinforcements shall be clean, free from grease, oil paint, dirt, loose mill scale, loose rust, dust bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer. If welding is approved, the work shall be carried out as per IS:2751 according to the best modern practices and as directed by the Engineer. In all cases of important connections, tests shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Engineer, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

7.4 LAPS

Laps and splices for reinforcement shall be as per IS:456. Splices in adjacent bars shall be staggered and the locations of all splices shall be approved by the Engineer.

7.5 BENDING

Reinforcement bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars. All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material; bars containing cracks/splits shall be rejected. They shall be bent cold, except bars of over 25 mm in diameter which may be bent hot if specifically approved by the Engineer. Bars which depend for their strength of cold working shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (nor exceeding 845°C) and after bending shall be allowed to cool slowly without quenching. Bars

incorrectly bent shall be used only if the means used for straightening and re-bending be such as shall not, in the opinion of the Engineer, injure the material. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

7.6 FIXING

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the approved Drawings by the use of blocks, spacers and chairs, as per IS:2502, to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

7.7 NOMINAL COVER TO REINFORCEMENT

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. It is the dimension used in design and indicated in the drawings. It shall be not less than the diameter of the bar.

Minimum values for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure described in Clause-8.2.3 and as given in Table –16 of IS:456/2000.

However for a longitudinal reinforcing bar in a column nominal cover shall in any case not be less than 40 mm, or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bars do not exceed 12 mm, a nominal cover of 25 mm may be used.

For footings minimum cover shall be 50 mm.

Table-16 of IS:456/2000 – Nominal cover to Meet Durability Requirements

Exposure	**Nominal Concrete cover in mm not less than**
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on sub-grade shall be supported on pre-case concrete blocks as approved by the Engineer. The use of pebbles or stones shall not be permitted.

The 28 days crushing strength of cement mortar cubes/pre-cast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.
The minimum clear distance between reinforcing bars shall be in accordance with IS:456.

7.8 INSPECTION

Erected and secured reinforcement shall be inspected and approved by the Engineer prior to placement of concrete.

7.9 WELDING OF REINFORCEMENT

Reinforcement which is specified to be welded shall be welded by any process which conforms with the requirements of IS:2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no departure from this procedure shall be permitted.

Welds in positions other than those shown on the approved Drawings shall not be permitted. Tack welding to lightly secure reinforcement in place will be permitted subject to approval of the Engineer.

7.10 SUPPLY OF REINFORCING BARS

Contractor shall make their own arrangements for the supply of steel reinforcement, MS bars/high yield strength deformed bars etc. required for the works. Further, the Contractor shall be responsible for payments of applicable duties and taxes etc.

End of Chapter 7

CHAPTER 8

SEWER APPURTENANCES

8.1 MACHINE HOLE

The machine holes shall be provided with Pre cast or Cast in situ RCC machine holes depending upon diameter of sewers and depending upon the alignment of proposed sewer whether it is on road or in Storm Water Drain (SWD) or as directed by Engineer Incharge

The RCC machine hole are defined with the following conditions.

- RCC machine hole – 900 mm dia. pipe and above for all depths
- RCC machine hole – In SWD, for all dia. of pipe and for all depths.

The Brick Machine hole shall be constructed as per IS 4111- Part-1

(i) Location

Machine hole shall be constructed at places as shown on relevant drawings and as

directed by the Engineer-in-charge.

(ii) Excavation

Excavation, shoring, dewatering etc. for the pits of machine hole shall be done in

accordance with specification.

(iii) Cement Mortar

Mortar for brick masonry shall be prepared as per IS: 2250. Machine hole shall be constructed in brick masonry with cement mortar (1:4), 20 mm thick inside plaster and 12 mm thick outside plaster in CM 1:3, unless otherwise specified in items. Gauge boxes for sand shall be of such dimensions that one bag containing 50 Kg. of cement forms one unit. The sand shall be free from clay, shale, loan, alkali and organic matter

and shall be of sound, hard, clean and durable particles. Sand shall be as approved by Engineer. If so directed by the Engineer, sand shall be thoroughly washed, till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

Contractor shall arrange for test on mortar samples if so directed by the Engineer. Retempering of mortar shall not be permitted.

(v) Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm. with a hooked tool made for the purpose when the mortar is still green and in any case within 46 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as specified on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. The decision as to when the plaster has hardened will be given by the Engineer-in-charge. Curing shall be done by continuously applying water in fine spray and shall be carried out for at least 7 days.

Plastering shall be done on both faces of brick masonry, 20 mm thick inside and 12 mm thick outside.

The machine hole shall be internally provided with **PVC/Poly Urea lining of thickness 1.5 mm** to protect the walls and top from corrosion developed due to sewer gases such as H2S etc.

(vii) Cement concrete channel

The channel for the machine holes shall be constructed in cement concrete of M25 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer.

They shall be benched up in concrete extended vertically 50mm above and rendered in cement mortar (1:2) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

The branch channels also be similarly constructed with respect to the benching but at their junctions with main channel, an appropriate fall, if required suitably rounded off, in the direction of flow in main channel shall be given.

The machine hole shall be constructed at places shown on the drawings or wherever directed by the Engineer.

(viii) Pipe entering or leaving machine holes

Whenever a pipe enters or leaves a machine holes, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

(ix) Rungs / foot steps

Rungs / footsteps shall be provided in all machine hole and shall be Manufacture and conforms to the dimensions of IS 5455:1969(RA1977) are reinforcement encapsulated with PVC. The surface finish shall have 2mm tread on top by ribbing or chequering. These rungs may be 300 mm apart vertically and shall project a minimum of 100 mm beyond the finished surface of the machine holes wall. The top rung shall be 450 mm below the machine holes cover and the lowest not more than 300 mm above the benching. Rungs shall be tested as per IS and approved before usage.

(x) Frame and covers

Frame and covers for machine hole shall be of required type and dimensions as per the relevant drawings.

Following information shall be clearly marked on each cover.

a. Year of manufacture
b. Identification mark of the purchaser
c. SEWER / SWD
d. Arrow showing direction of flow
e. Name of manufacturer / Trade mark

(xi) Steel Fibre Reinforced Concrete (SFRC) Frame and Cover

Steel Fibre Reinforced Concrete (SFRC) frame and cover shall be as manufactured as per IS 12592. (Latest edition). The contractor to submit the structural design and drawing of frame and cover and get it approved before manufacturing the same.

(xii) Drop Machine holes

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a machine holes shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer

(xiii) RCC Machine holes

In general, plain and reinforced concrete work for machine hole shall be carried out in accordance with the specification and drawing.

(xiv) Measurement

Machine hole

The depth of machine holes shall be measure from the top of cover to the invert level of the deepest outgoing sewer from the machine holes. The relevant items of machine holes quoted in schedule of quantities and drawings. The measurement shall be per number basis and as per the actual depth of machine holes constructed.

8.2 EXISTING CONNECTIONS

All existing connections which are removed during the uprooting of the existing sewer shall be replaced and reconnected with new sewer as per the directions of the Engineer. The replaced new sewer connections shall be properly laid, jointed and connected as per the directions of the Engineer. During the execution work of replacing sewer if the bedding of the connection has been disturbed it shall be replaced with new bedding as per specification contained in the tender document. After making the connection to the sewer, back filling shall be done in layers as directed by the Engineer.

8.3 VENTILATION SHAFTS

Ventilation shafts are to be provided for the machine hole in SWD as shown in drawing. The connecting pipe from machine holes to ventilating shaft should be DI K-9 150 mm diameter. A foundation block of 150mm thick PCC in M15 is provided surrounding the pipe.

The vertical shaft should be made of ductile iron and it should be around 6 m high above the ground level and the internal diameter of the shaft should be 150 mm. All the dimensions are to be taken as per tender drawing. The joint of pipes forming the ventilating shaft should be made air tight. The location of the ventilating shaft should be such that it should not cause any nuisance to the vehicular traffic and the movement of pedestrians. The placing of ventilating shaft should be as per the directions of Engineer in charge. The details of fixing the ventilating shafts are provided in the drawing given in the tender document.The ventilating shafts if required shall be informed by Engineer Incharge

8.4 NEW HOUSE CONNECTIONS

The new house connections along the side of the storm water drain and the existing sewer connections connected at present to the storm water drain shall be disconnected to the storm water drain and be connected to the newly replaced sewer. While doing so the contractor has to dismantle the storm water drain for the new connection. After properly connecting the above connections to the new replaced sewer, contractor shall reconstruct all the broken storm water drains and the rate for making the new connections shall also include the rectification of storm water drains. If the numbers of connections are more in a particular stretch contactor shall put a rider main along the side of storm water drain and connect it to the nearest D/S machine holes. Separate payment will be made as per Bill of Quantities for the rider main. Therefore the contractor shall inform the Engineer well in advance about the new connections or existing connections to the Engineer and the Engineer's decision for above two alternatives shall be final and binding on the contractor.

8.5 CONCRETE CRADLES, HAUNCHING, ETC.

The concrete cradles shall be constructed in situ by the contractor, indicated in the drawings, in places wherever required as decided by the Engineer.

Notes

If any damage is caused to the other services such as water supply pipeline, sewer, cable etc. during the construction of machine hole Contractor shall be held responsible for the same and shall replace the damaged services at his own cost to the full satisfaction of the Engineer.

The interior of machine hole shall be cleared of all debris after construction and before testing the same for water tightness by Contractor at his own cost.

Water for testing of machine hole along with pipeline shall be arranged by Contractor at his own cost.

CHAPTER 9

SPECIFICATION FOR SFRC MACHINE HOLES COVERS

9.1 SCOPE

Contractor's scope includes the design, manufacture, supplying and fixing the FRC machine holes frame and covers. The wet concrete mix is subjected to pressure applied through a hydraulic jack through a plunger kept at the top of the wet mix. The FRC machine holes covers shall be able to resist 35 tonnes load bearing capacity. The thickness of the heavy duty machine holes covers shall not be less than 10.5 cm. A 25x3 mm thick MS Flat all around the frame is welded to the main reinforcement of the frame so as to get a clear opening of 600 mm diameter. A 18 SWG MS strap all around the cover and lifting arrangement of 12 mm diameter MS bars welded to the main reinforcement are also to be provided for lifting the machine holes covers. A coat of epoxy paint shall be applied to the underside and sides of the frame and cover.

GENERAL

a) The quality of materials, method of testing shall be approved by the Engineer in Charge.

b) The Engineer shall have the right to inspect the source/s of material/s, the layout and procurement, the equipment, quality control system, testing of material etc. If the Engineer desires the sample of the FRC cover or materials used for the manufacture of FRC covers, test certificate from approved laboratory. Then the contractor shall arrange the same without any extra cost.

MATERIAL

a) Cement

Unless otherwise specified in the specification or called for the engineer, cement shall be ordinary Portland cement as per the relevant IS code. More details are mentioned on the section of concrete under this tender document.

b) Fine aggregates

The details of this have been mentioned in the section concrete and allied works of this tender document.

c) Coarse aggregate

Coarse aggregate for concrete, shall conform to IS 383. This shall consist of crushed stone and shall be clean and free from elongated flaky or laminated pieces, adhering coating, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or

other deleterious matter, The maximum size of the aggregate shall be 12 mm .

d) Water

Water for use in concrete and curing shall conform to IS 456/1964 and its subsequent amendments.

e) Water/cement ratio

The water-cement ratio shall *be 0.40 to 0.45 to* yield a good workability. The workability can be increased by using appropriate admixtures.

f) Fiber Reinforcement

The fibers are cut from 0.40 mm dia high tensile steel wires of about 12000 kg/cm2 ultimate stress. The fiber content for the manufacture of FRC covers is of the order 1 to 1.25% by volume of the concrete.

g) Design Mix

The vendor shall design the mix design of the concrete which is expected to give a concrete compressive strength of about 350 kg/cm^2 at 28 days.

h) Mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

i) Placing and Compaction

The reinforcement shall be placed in proper position in steel moulds coated with a thin layer of mould oil. Concrete shall be filled to slightly overfill the moulds and compacted by vibration and struck off level with a trowel.

Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommended since the holes left by the vibrator in the wet mix may not close after its removal owing to interlocking of the fibres with the mix. Compaction by means of shutter or form or table vibrators is recommended. In case of extra heavy duty and heavy duty cover frames, compaction by means of pressure cum-vibration technique may also be employed so as to achieve dense and strong concrete. Clear cover to reinforcement shall be not less than 15 mm. After de-moulding, cover frames shall be protected until they are sufficiently hardened to permit handling without damage.

j) Curing

The hardened concrete machine holes cover frame shall be placed in a curing water tank or taken to the curing yard where they shall be kept continuously moist for at least 28 days. Frames may be water cured by immersion in water, covering with water saturated material or by a system of perforated pipes. Mechanical sprinklers or any other approved method that will keep covering frames moist during the specified curing period. Steam curing of machine holes cover frames may be adopted instead of method specified above provided the requirements of pressure or non pressure steam curing are fulfilled and the machine holes cover frames meet the requirements specified in this section.

k) Edge Protection and Finishing

The top and inside surface of cover frames shall be smooth. To prevent the top outer edge from possible damages, it shall be protected by 25 mm x 3 mm mild steel flat as part of the frame. Sufficient number of steel connectors shall be welded to the inner surface of the mild steel flat so as to connect it with the frame reinforcement and these shall be embedded in the concrete during casting. Exposed surface of mild steel flat shall be given suitable treatment with anticorrosive paint or coating. Suitable arrangements may be made for fixing the machine holes cover frames in position on the machine hole by mutual agreement between the manufacturer and the purchaser.

l) Physical requirements

GENERAL

All the frames shall be sound and free from cracks and other defects which interferes with the proper placing of the units or impair the strength or performance of the units. Minor chippings resulting from the customary methods of handling and transportation shall not be deemed ground for rejection.

m) Dimensions

The inside dimensions at top shall match with the corresponding covers so that the maximum clearance at top between the frame and the cover is not more than 5 mm and the top surface of the frame and cover is in level within a tolerance of .± 5 mm.

h) Scale of Sampling

LOT

In a consignment 500 precast concrete machine holes cover frames or a part thereof, of the same type and dimensions and belonging to the same batch of manufacturer, shall be grouped together to constitute a lot For ascertaining conformity to the materials in the lot to requirements of this specification, samples shall be tested from each lot separately. The number of

cover frames to be selected from the lot shall depend on the size of lot and shall be according to the following table:

SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES

No. of cover Frames in the Lot Dimensional Requirement

	Sample Size	Acceptance Number
Up to 100	**10**	**1**
101 to 200	**15**	**1**
201 to 300	**20**	**2**
301 to 500	**30**	**3**

CHAPTER 10

RCC SOCKET SPIGOT NON-PRESSURE PIPES

10.1 GENERAL

RCC NP3 and RCC NP4 class pipes shall be used as per the requirement. These pipes shall be in accordance with the specifications mentioned in IS:458-2003 and its Amendments. Further, the Contractor can use other materials like DI/HDPE etc. with the prior consent of the Employer along with sufficient evidence for proof that the materials which he is proposing for substitution will result in higher performance than the one which is mentioned. These proposed pipes shall be in accordance with the specifications mentioned in relevant IS and for which no extra cost other than the one which is mentioned in BOQ will be paid.

MATERIALS

For pre-cast reinforced concrete pipes, materials complying with the requirements given in (i) to (v) shall be used.

i) Cement

Cement used for 1000mm and above size RCC NP3 pipes shall be manufactured with Sulphate Resistant Cement and conforms to 12269:1987 (RA2004).

Cement used for up to 900mm size RCC NP3 pipe should be manufactured with Sulphate resistant cement and conforms to IS12330:1988 (RA2005)

ii) Aggregates

Aggregates used for the manufacture of reinforced concrete pipes shall conform to IS:383;1970. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20 mm, whichever is smaller.

iii) Reinforcement

Reinforcement used for the manufacture of the reinforced concrete pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part1):1982(RA2004)' or hard drawn steel wire conforming to IS 432 (Part 2) or structural steel (standard quality) bars conforming to IC 2062.

iv) Concrete or Mortar

The quality and design mix requirements of concrete (concrete mix, maximum water-cement ratio, minimum cement content, etc) used for the manufacture of reinforced cement concrete pipes and collars shall conform to IS: 456-2000 for at least very severe environment exposure condition and shall also be in accordance with Concrete and Allied works Section of Technical Specifications. In case of pipes cast by spinning process, higher cement contents, more fines and higher water-cement ratio may be the need of the process.

The concrete for non-pressure pipes shall have a minimum compressive strength of 35 N/mm2 at 28 days. If mortar is used, it shall have a minimum cement content of 450kg/m^3 and a compressive strength not less than 35 N/mm2 at 28 days.

Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS:456-2000 and IS:516-1959.

The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix.

v) Rubber Ring

Rubber ring chords used in pipe Joints shall conform to Type 2 of IS:5382-1985.Rubbers rings shall be tested and approved before usage.

vi) The pipes shall be provided either with High Alumina Cement or Poly Urea internal lining to protect from corrosion thus ensuring long life.

10.2 DESIGN

i) General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure does not exceed the limit of 125 N/mm^2 in the case of mild steel rods, 140 N/mm^2 in the case of hard-drawn steel wires and high strength deformed steel bars and wires.

The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcement shall not exceed 1.5 N/mm^2 for non-pressure pipes. The barrel wall thickness shall be as per IS:458-2003.

Longitudinal reinforcement shall be provided to ensure rigidity and correct location of cages (grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in respective tables of IS:458.

ii) Reinforcement

The reinforcement in the reinforced concrete pipe shall extend throughout the length of the pipe and shall be so designed that it may be readily placed and maintained to designed shape and in the proper position within the pipe mould during the manufacturing process. The circumferential and longitudinal reinforcement shall be adequate to satisfy the requirements specified under (i).

The pitch of circumferential reinforcement shall be not more than the following:

a) 200 mm for pipes of nominal internal diameter 80 to 150 mm,
b) 150 mm for pipes of nominal internal diameter 200 to 350 mm, and
c) 100 mm for pipes of nominal internal diameter 400 mm and above.

The pitch shall also be not less than the maximum size of aggregate plus the diameter of the reinforcement bar used.

The quantity and disposition of steel in pipes may be decided by mutual agreement between the BWSSB and the supplier; however, it shall be proved by calculations and tests that the quality of the pipes conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in the respective tables of IS:458 shall be used as minimum reinforcement.

If so required by the BWSSB, the manufacturer shall give a certificate indicating the details relating to quality, quantity and dispersion of steel in the pipes as well as the clear cover to the steel provided in the pipe.

i) Ends of Pipes

Dimensions of spigot and socket for rubber ring roll on jointed pipes shall be as given in the respective tables of IS:458. Reinforcement in socket of rubber ring jointed pipes shall be as given in the respective tables of IS:458-2003.

10.3 MANUFACTURE

i) General

The methods of manufacture shall be such that the form and dimensions of the finished pipe are accurate within the limits specified in this standard. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis.

ii) Concrete mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour ad consistency, but in no case shall the mixing be done for less than two minutes. Water-cement ratio shall be less than 0.5.

The concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning. Vibrating, spinning combined with vibrations, or other appropriate mechanical means.

iii) Reinforcement Cages

Reinforcement cages for pipes shall extend throughout the length of pipe barrel. The cages shall consist of spirals or rings and straight of hard-drawn steel wire or mild steel rod and may be circular. Circular cages and longitudinal reinforcement shall be placed symmetrically with respect to the thickness of the pipe wall. The spirals shall end in a complete ring at both the ends of a pipe.

Pipes having barrel thickness **above 100 mm** shall have double reinforcement cage and the amount of steel in the outer cage shall be 75% of the mass of the inner cage whilst the total shall conform to the requirements specified in the relevant tables of IS 458 : 2003. The total longitudinal steel per pipe shall be given in the relevant tables of the standard but the distribution shall be such that the round shape of the cage is not disturbed.

Diagonal reinforcement may be provided in pipes for which the cages are not welded so as to help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4 of IS 458.** If diagonal reinforcement is provided, it shall be considered as part of process requirement and shall not be counted against the longitudinal reinforcement and spiral reinforcement. Single reinforcement cage shall be located near the inner surface of the pipe with adequate clear cover.

iv) Water Curing

Pipes manufactured in compliance with this standard shall be water cured for a period of not less than 2 weeks in case of pipes made from ordinary Portland Cement or Portland slag cement or Portland Pozzuolana cement or hydrophobic Portland cement, and not less than 1 week in case of pipes made from rapid-hardening Portland cement or 53 grade ordinary Portland cement. Pipes may be water-saturated material or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other approved method that will keep the pipe moist during the specified curing period. In the case of large pipe projecting partly above the water level, the projected portion shall be kept wet by any suitable means.

10.4 DIMENSIONS

10.4.1 Pipes

The internal diameter, wall thickness, length of pipes, minimum reinforcements and strength test requirements for different classes of pipes shall be as specified in the respective tables of IS 458. The manufacturer shall inform the **BWSSB** of the effective length of spigot and socket that he is able to supply.

10.4.2 Tolerances

The following tolerances shall be permitted:

Sr. No.	Dimensions	Tolerences
i)	Overall Length	: ± 1% of Standard Length.
ii)	Internal Diameters of Pipes	
a)	Up to end including 300mm	: ± 3 mm
b)	Over 300mm and up to and including 600mm	: ± 5 mm
c)	Over 600mm	: ± 10mm
iii)	Barrel Wall Thickness	
d)	Up to end including 30mm	:+2mm :−1mm
e)	Over 300mm and up to and including 50mm	: +3mm : −1.5mm
f)	Over 50mm and up to and including 65mm	:+4mm :−2mm
g)	Over 65mm and up to and including 80mm	: +5mm : −2.5mm
h)	Over 80mm and up to and including 95mm	:+6mm :−3mm
i)	Over 95mm	: +7mm : −3.5mm

Note:

In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in Tables 13 to 19 of IS:458.

10.5 WORKMANSHIP AND FINISH

i) Finish

Pipes shall be straight and free from cracks except that craze cracks may be permitted The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter

The outside and inside surfaces of pipes shall be dense and hard and shall not be coated with cement wash. The inside surface of pipe shall be smooth. For better bond the inner surface of the collar may be finished rough.

The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Pipes shall be free from local dents or bulges greater than 3.0 mm in depth and dents and bulges shall not be extending over a length in any direction greater than twice the thickness of barrel.

Pipes may be repaired, if necessary, because of accidental injury during manufacture of handling and shall be accepted if in the opinion of the BWSSB, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

ii) Deviation from Straight

The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge as described in IS 3597 shall not exceed, for all diameters, 3 mm for every meter run.

10.6 TESTS, SAMPLING, INSPECTION and MARKING

All RCC S/S Non-pressure pipes are to be tested, for the numbers/scale of sampling and inspected and clearly marked as per the relevant clauses (10, 11 and 12) in IS:458-2003.

10.7 TRANSPORT AND HANDLING OF PIPES AND OTHER MATERIALS

The specification for transport and handling of pipes shall conform to IS:783-1985 unless otherwise specified.

a) The R.C.C. pipes, base plates, machine holes frames and covers, bolts and nuts, clamps etc., shall be transported by the contractor for laying and construction work at the respective sites of work at his own cost.
b) It is essential to transport, handle and lay the pipes, materials, etc in such a manner as not to cause damage. In lorry/truck shipments, the pipe shall be supported in wide cradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of pipe,

and all chains, calves, or other equipment used for fastening the load shall be carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used instead of hollowed out timbers. Pipes shall not be thrown down from the lorries/trucks nor shall that be dragged or rolled along hard surfaces. Slings of canvas or equally nonabrasive materials of suitable width or special attachment shaped to fit the pipe ends shall be used for lifting and lowering pipes so as to eliminate the risk of damage,

c) Great care shall be taken in handling the pipes right from the first operation until they are laid and jointed. The contractor shall be responsible for any loss or damage to the pipes and other materials.

10.8 PERMISSION TO LAY PIPE, CONCRETE

When any portion of the excavation shall have been carried down to the necessary depth, the contractor shall obtain permission from the Engineer before commencing the laying of pipes or concrete.

10.9 LAYING AND JOINTING OF SEWERS

a) The specification for laying and jointing of RCC pipes shall conform generally to
I.S,783-1985 and amendments thereon.

b) These specifications cover the work of laying all RCC pipe lines, under ground and above ground, including all civil works required for the same.

(a) The contractor shall manufacture the pipes for a length of maximum 500 m at a time. All these pipes should not be conveyed to the site at a stretch, Contractor shall carefully convey and stack the pipes along the side of the road at every two machine holes lengths only. and this should not affect the traffic and pedestrians.

10.10 (a) LAYING AND JOINTING OF R.C.C. PIPES

a) Before commencing the work of pipe laying the contractor shall study the longitudinal section and other relevant details of the pipe line for the section/reach concerned. Pedestals/ cradles to be provided for shall be constructed before commencing the pipe laying work in any section, If the pipes are required to be wholly encased in concrete encasement of the pipes shall be done as per the method decided by the Engineer.

b) The contractor should check all pipes, rubber rings and other materials before hand and satisfy himself and intimate, the department if any defects are noticed or if the quality is found to be not to standard.

c) All pipes shall be carefully handled and lowered into the trench by means of proper methods of handling. The pipes shall be handled by flat rubber belts.

d) Socket should face the opposite to the direction of flow. Pipe shall be normally laid so that spigot end enters the socket face. The

socket and spigot ends of the pipe shall be cleared of all extraneous matter specially of clay and grease. Rubber ring shall be clean and dry.

e) All the pipes shall be laid perfectly true both in line and grade specified in the drawings. the rubber rings shall be kept evenly positioned on the spigot groove and when satisfied that the pipe and rubber ring are correctly positioned, the pipe shall be forced/pushed well right home of the full depth of the joint by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber ring shall conform to 1S:53821985. Inside the joint, the two pipe ends shall be in close proximity. Properly fitted temporary wooden stoppers shall be provided and constantly used to close the ends of all in completed pipe lines.

f) Bailing or pumping out of water from trench including shoring, strutting and removing slush while laying, jointing and testing shall be done by the contractor. Caving, sliding, under pinning, floatation are some of the features to be kept in view by the contractor and he shall take all required/necessary special precautions during the course of execution. The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage. Precautionary works such as blank-flanging the open ends of the pipe line shall be taken up at the contractor's account and no separate payment will be made for the same. Should any section of the pipe line float during the contract period, the entire cost of laying it again to the correct line and level shall be to the account of the contractor.

g) Blank flanges

Blank flanges shall be provided at all ends left unattended for the temporary closure of work. At the end of a day's work, also suitable closures shall invariably be provided at the open end or ends to protect the pipe line from ingress of sub-soil water, mud, muck, debris, dust etc.

h) Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, to carry out final connection, the contractor should take all special precautions such as maintaining the levels, grades, alignment keeping in view the length of pipes. If any mistake or error occurs, the contractor shall relay the entire stretch at his cost. Any losses or damages either to pipes or other material thereupon shall be at the contractor's expense and necessary recoveries shall be made.

i) Precautions against floatation

When pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench or cutting, it is subjected to an uplift pressure due to buoyancy and is likely to float, completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation by providing sufficient overburden or by providing sufficient dead weight by means of anchor blocks.

In the case of the work extending into the monsoon season, however, special care and precautions are necessary during the progress of work on this account. The work of providing anchor blocks and refilling the trenches to the required level and compacting the same etc. shall always be done as soon as the pipeline has been laid.

The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage, precautionary work such as blank-flanging the open ends of the pipeline and filling the pipeline with water etc. shall be taken as directed by the Engineer. Such works shall be to the contractor's account and no separate payment will be made for the same. A two metres over burden shall be maintained at all times. Where this overburden is not available, anchor blocks have to be provided.

Protection of pipeline against floatation during the contract period shall be the responsibility of contractor. Should any section of the pipe line float due to their negligence etc, the entire cost of laying it again to the correct line and level shall be to his account.

10.11 METHODS OF MEASUREMENT

1. For manufacture, supply and delivery of pipes, measurement shall be taken for actual number of pipes multiplied by the standard length.
2. Machine hole shall be measured per machine holes as provided in the Bill of Quantities.
3. Laying and jointing of pipes and specials and valves will be measured in linear meters along the centre line of the pipes actually laid, jointed and tested and will be limited to the number of pipes x standard length + part length of pipe if any. The rate shall include the cost of rubber ring.
4. Anti floatation blocks, pedestals and any other concrete structures shall be measured volumetric ally (cum.).

10.12 SPECIFICATION FOR SULPHATE RESISTANCE CEMENT PIPES AND HIGH ALUMINA CEMENT LINED PIPES

10.12.1 GENERAL

Pipes up to and including 900mm dia should be manufactured with Sulphate Resistant (SR) Cement confirming to IS: 12330-1988.

Pipes up to and including 900mm dia shall be lined with 12mm thick high alumina cement with SR cement. The main purpose of using High Alumina Cement for lining is to protect the pipe against sulphate attacks when it is used in sewer lines.

The normal proportion of the mix shall be as follows:

1. High Alumina cement one part- as per IS:6452.
2. Granite dust passing through I.S. sieve 150 micron-one part
3. Fine aggregate passing through I.S. sieve 1.18 mm as per I.S.383
4. Water cement ratio of the lining mix shall not be more than 0.35 and shall be sufficient to ensure maximum density.

10.12.2 PROCESS OF MANUFACTURE

The pipes shall be made by spinning process. The centrifugal force generated by spinning action will force the concrete against the mould, removing excess resulting in a dense concrete.

The mix for High Alumina cement lining shall be mixed in small separation mixer.

All the ingredients shall be weighed. As soon as the spinning of pipe is completed, the cement mortar shall be fed into the rotating mould uniformly and the pipe shall be spun until the cement mortar is set.

10.12.3 PRECAUTION TO BE TAKEN FOR HIGH ALUMINA LINING

1. It is not desirable to mix and do the lining in high constant temperature (temperatures more than 40 C). Hence, it is advisable to manufacture the pipe when temperature is lower than 40C.
2. Stream curing should not be used for curing pipes.
3. The high alumina lining shall be kept moist and cool for the first 24 hours. The curing of lining shall be started after 3 to 4 hours after operation.
4. The water cement ratio of the lining shall not be more than 0.35

CHAPTER -11

PIPE JACKING

11.1 Pipe Jacking

General

(a) Where required, sections of the pipeline shall be laid by pipe jacking. The Contractor shall engage a professional having experience in Trenchless Technology to design and be responsible for the supervision of the construction of the jacking pits.

(b) Plans and details of the equipment, materials and the method of construction to perform and complete the work shall be submitted by the Contractor and must be approved by the Engineer in charge before commencing these operations. Approval of the Engineer in charge shall not relieve the Contractor of his sole responsibility for the efficacy, reliability, soundness of the method employed in completing the work in a satisfactory manner.

(c) It shall be the responsibility of the Contractor to satisfy himself as to the soil conditions along the pipe jacking route and if he judges it to be necessary, he shall carry out soil investigations at his own cost.

(d) It shall be the responsibility of the Contractor to maintain stable soil conditions at the jacking face to prevent loss of ground above the jacking operation and movement of the surrounding earth. The methods of maintaining face stability and preventing ground movement and subsidence shall be by means of compressed air or other plenum methods where fluid slurry or earth pressure is applied to the tunnel face. Alternatively, unstable ground ahead of the jacking face may be stabilized by the injection of suitable chemicals. Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss. The Contractor's proposal must be submitted to the Engineers incharge for his approval.

(e) It is the Contractor's responsibility in ensuring that the pipe jacking machines are installed and removed at the designated launching and receiving pits. In the event that any additional pits need to be installed to either remove any obstruction at the face of the jacking machine, failure of jacking of machine or for any other reason, the Contractor shall bear all cost incurred in constructing the jacking pits and reinstating the ground to the original condition, subject to the approval of the relevant authority eg BMP, BDA, Police and the satisfaction of the Engineers incharge.

(f) Movement or settlement of structures, utilities and pavement shall be monitored by the Contractor during the jacking operation and reported to the Engineers incharge. If movement or settlement occurs which, in the opinion of the Engineer in charge may cause damage, the Contractor shall take immediate action to prevent further movement, settlement or damage. The Contractor shall repair at his own cost any damage and restore structures or pavements to the satisfaction of the Engineer in charge. Any damage to utilities during the execution shall be rectified by Contractor on his own cost.

(g) The Contractor shall be responsible for inspecting the location and familiarizing himself with the conditions under which the work will be performed and with all necessary details as to the orderly execution of the work. The omission of any details shall not relieve the Contractor

of full responsibility for the satisfactory installation of the work in its entirety. No monetary or other claims made by the Contractor on the grounds of want of knowledge will be entertained by the Board.

(h) (g) The Contractor shall co-operate and shall have proper understanding about other contract packages of S4 components

(i) The Contractor shall have to work with a mutually agreeable Bench Mark under other contract packages of S4 components.

(j) The Contractor shall have to liaison with other utility agency like BMP, BDA, Police, KPTCL, BSNL and other private users to get proper permissions for the required work.

(k) The Contractor shall be paid as per BOQ i.e. per running meter basis. This includes the cost of all the activities, material, including the MS casing pipe items, investigation works, precautionary measures during execution including change in the approved methodology etc. There is no separate or addition payment.

Pipes for Jacking

(a) The pipes for jacking operation shall be MS pipe of as specified in the Bill of Quantities or as directed by the Engineer in charge. The carrier pipe of RCC NP3 pipe will be laid inside the MS pipe with proper joining & slopes as per specification & drawings.

(b) The supply of pipes shall be in accordance with the Specifications.

11.2 Precast Reinforced Concrete Pipes (Carrier Pipe)

(a) The precast reinforced concrete pipes shall be manufactured by a centrifugal or other equivalent process to be approved by the Engineer in charge. Design, manufacture and factory testing of the pipes and specials shall be to as per IS 458 (Latest Revision) and BS 5911-I (Latest Revision). The clear cover of concrete over steel reinforcement shall not be less than 50 mm.

(b) All pipes except for those less than 900 mm diameter shall be manufactured with two sets of grout holes. Each set shall consist of three grout holes spaced at 120□ on centres circumferentially located at the quarter points from either end of the pipe. Two of these grout holes shall be at the soffit of the pipe.

(c)The strength of the pipes shall be tested by the three edge bearing test. When subjected to the design load in such a test, the maximum crack width developed on the pipe shall not exceed 0.25 mm. All such tests shall be carried out at the expense of the contractor.

(d) The contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and type of joints, calculations, together with the name of the proposed

manufacturer, the place of manufacture, and the manufacturing processes to the Engineers incharge for approval. All workmanship and materials used in the manufacture shall be subject to the approval of the Engineers in charge who shall from time to time be permitted to inspect materials at source and the manufacturing processes in the factory.

(e) The pipes shall be sufficiently matured before they are used in the construction of the works. They shall be handled with extreme care to prevent the edges of the pipes from chipping. Repaired pipes shall not be allowed for use in the contract. The Engineers incharge may reject any pipes he considers not suitable for the works and these rejected pipes shall be removed from the site immediately. After factory testing and before despatch, every pipe and special shall be marked in accordance with the standard used. In addition, each pipe shall be marked with a number corresponding with the order of manufacture. Test certificates from the manufacturers or other relevant authority shall be submitted to the Engineers incharge.

(e) Where steel collars are used for pipe joints, it shall be made of weldable structural steel Grade
430 with minimum yield strength of 275 N/mm^2 as specified in Table 2 of BS 3601. The collars shall be of dimension and thickness to be approved by the Engineers incharge. Before fitted to the pipes, the collars shall be coated with approved anti-abrasive and anti-corrosive materials such as polymorphic resin or equivalent. Joint seals shall be manufactured from EPDM, complying with the requirement of BS 7874 (Latest Revision).

(f) Where steel shield is utilised during the jacking operation, this steel shield shall be bolted to or by other approved means joined to the first piece of pipe which is being jacked.

(g) All the loading conditions during installation state and operation state to be submitted for the design review. Contractor shall submit the design of pipes for Engineers approval. Pipe shall be designed in accordance with the following standards (Latest Revisions):

IS: 456	Plain and Reinforced Concrete - Code of Practice
IS: 458	Precast Concrete Pipes (with and without Reinforcement)–
IS: 3370	Code of practice for concrete structures for the storage of liquids: (Part-
BS: 5911-I	Concrete pipes and ancillary concrete pipes, specification for unreinforced and reinforced pipes (including jacking
IS: 2062	Steel for general structural purposes
IS: 10748	Hot-rolled steel strips for welded tubes and pipes

Jacking Ring and Frame

(a) The Contractor shall be required to use a jacking ring. The jacking ring may be either of steel or concrete construction and shall be used at all times when a pipe is being jacked. This jacking ring will allow the jacking pressure to be distributed evenly around the wall of the pipe.

(b) The Contractor shall also be required to use a jacking frame during all operations. The jacking frame shall be designed to distribute the stresses from the jacks evenly to the jacking ring.

Jacking Operations

(a) The Contractor shall be fully responsible for the materials, equipment and facilities required in conjunction with jacking the concrete pipe.

(b) Before starting work, the Contractor shall submit to the Engineers incharge for approval, a detailed schedule of the entire jacking operation. Approval of such schedule shall not relieve the Contractor of his responsibility to provide a fully satisfactory installation. The Contractor shall be required to include with his submission evidence that he has successfully completed a jacking installation using procedures similar to those proposed.

(c) Where chemical stabilization of soil is used, a chemical grout shall be pressure injected into the soil over and ahead of the pipe jacking to stabilise the soil. The chemical grout used shall have a demonstrated history of success for stabilizing soils similar to that through which the pipe is to be jacked.

(d) Where a mechanical shield is used, the Contractor must provide proof that the particular model of shield has been used successfully in soils similar to that on the site. The crew for the operation of the shield must be specialist, with experience in the use of that particular type of machine.

(e) After the jacking operations has begun, the Contractor may have to work continuously (24 hours per day) if required and directed by the Engineers incharge until the complete length of jacked pipe is installed.

(d) The pipes shall be jacked into place, true to line and level. The maximum tolerance allowable in the displacement of the centreline of the laid pipe from the design centreline is 50 mm in the horizontal plane and 15 mm in the vertical plane but there shall be no back fall at any point. Any pipe which is not laid in its correct position must be removed and re laid or adjusted to obtain its correct position.

(e) For precast reinforced concrete pipes, there shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible material shall be provided at each joint and shall be securely held before the pipes are lowered

into the thrust pit. Details of proposals shall be submitted to the Engineers incharge for approval.

(f) The Contractor shall be required to furnish and install and remove to the extent required, thrust blocks or whatever provisions that may be required for backing up the jacks employed in driving the pipe forward. The jacking pit shall also be equipped with steel rails or beams embedded in concrete. These rails or beams will be used for placement and alignment of each pipe during the jacking operation.

(g) The Contractor shall be fully responsible for the design and construction of the jacking and receiving pits, thrusting wall, installation of jacking equipment, sheeting, bracing etc. and for the efficient execution of the jacking operation. Full details of the proposals, including plant, shield machine, equipment, operating procedures, jacking pit and intermediate jacking stations etc, shall be submitted to the Engineers incharge and shall be fully satisfactory to him before construction work begins. However, review of the plans shall not relieve the Contractor from his responsibility to provide a safe and satisfactory jacking pit.

(h) The Contractor shall be required to monitor closely the progress of the jacking operation. Daily site records of thrusting pressures and the line and level measurements shall be properly maintained and shall be available to the Engineers incharge at all times.

(i) It is the responsibility of the Contractor to ensure that the complete "tunnels" are watertight. If leakage occurs before completion or during the maintenance period, the Contractor shall carry out any remedial work that may be necessary to make the Works watertight all at his own expense. Contractor shall carry out the hydraulic testing as per IS 458 (Latest Revision).

(j) Contractor shall follow all safe working practices according to IS-4756 (Latest Revision) and BS-6164 (Latest Revision).

Cement Grouting

(a) The Contractor shall be fully responsible for preventing the occurrence of voids outside the pipe and if they occur he shall fill them with cement grout.

(b) Immediately following the jacking operation, the Contractor shall pressure grout the jacked section to fill all voids existing outside the pipe.

(c) (c) Systems of standard pipe, fittings, hose, and special grouting outlets embedded in the pipe walls shall be provided by the Contractor. Care shall be taken to ensure that all parts of the system are maintained free from dirt. Grout composed of cement, sand and other approved compound and water shall be forced under pressure into the grouting connections at the invert and shall proceed until grout begins to flow from upper connections. Connections shall then be made to these holes and the operation continued to completion.

(d) Apparatus for mixing and placing grout shall be of a type approved by the Engineers incharge. It shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous uninterrupted flow.

(e) After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devices until the grout has set sufficiently. After the grout is set, grout holes shall be completely filled with dense concrete and finished neatly without evidence of voids or projections.

11.3 Methods of Construction - Break-Outs from Shafts and Tunnels

(a) For the junctions of tunnels and shafts the Contractor shall submit, for the Engineer In charge's agreement a method statement describing the details of the work, with drawings and calculations.

(b) Tunnel and shaft linings shall not be broken out until all necessary temporary works, including ground treatment, where appropriate, have been completed to ensure the structural and geotechnical stability of the works.

(c)Temporary supports shall not be removed until so agreed by the Engineer in charge and the work for which they are required has been completed and the structure is capable of carrying the imposed loads. Once junction work is commenced it shall be completed as expeditiously as practicable.

(d) The break-out shall be of sufficient dimensions to accommodate the permanent structure to be built. Working space shall be kept to the minimum dimensions practicable.

(f) The break-up for a tunnel shall enable the construction of a stable initial length of an adequate tunnel lining, built within the specified construction tolerances.

(g) Ground improvement or other acceptable means shall be provided at shaft break-outs and break-ins as required to prevent instability of the ground as the sewer excavation exits or enters a shaft and elsewhere as required.

(h) The Contractor is deemed to have included in their price the cost of the interface with other contract including any ground improvement required to allow the access to the shaft or for the pipe jacking machine to be recovered as part of the works. The contract interface works are deemed to include shaft break-in or shaft breakout.

11.4 Limits of Surface Settlement

The method of jacking adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield during the jacking operations do not exceed 25 mm and the maximum surface settlement after the tail voids are grouted shall not exceed 50 mm. Subsequently, the ground shall be reinstated to the original level not with standing, for the sections of pipeline near to sensitive structures, crossing under all roads along the route of the pipeline and paved area, the

Contractor shall be required to incorporate in his jacking method measures to arrest the expected settlements so as to safeguard the integrity of the structures and road surfaces at all times. The Contractor shall ensure that the operational functions of these sensitive structures and traffic flows along all roads are not affected in any way by his work.

11.5 Shafts

Shafts - General

a) The working shaft shall be used for the construction of a machine holes/chamber. The Contractor to construct the Jacking & Receiving pit as a permanent structural in RCC which would be served as a machine holes during operation. The Jacking pit/Receiving pit would be converted into the machine hole with necessary modifications including construction of the top slab, machine holes cover frame, pipe benching, CI rungs etc. The Contractor to prepare the design & drawings as per the permanent structure requirements & shall be got it approved from the engineer.

(b) The Contractor shall submit for approval to the Engineers in charge dimensioned drawings and calculations of the timbering or trench sheeting details for the working shafts. Each working shaft shall have a separate ladder bay for access, which shall be isolated from the part of the shaft used for hoisting materials.

(c) Prior to excavation, the shaft area shall be thoroughly checked for existing utilities and the appropriate measures taken in agreement with the Engineers incharge.

Shafts - Safety

(a) Shafts shall be provided with guard rails or rings at least 1.2 m above the surrounding ground level.

(b) Once sunk to final level, the shafts for regular personnel access shall be equipped with ladders and landings at intervals not exceeding 6 m. Protection shall be so provided

that neither ladders, supporting structures, nor persons using them are subject to risk

of accident, from the passage of skips, spoil or materials. All ladders are to be secured at the top and bottom.

(c) Should heavy plant and heavy loads have to be located in close proximity to any shaft, the Contractor shall take into account the effects of these loads as well as any ground loads when designing the shaft.

(d) The Contractor shall guard against distortion of shaft lining during construction and the

possibility of shaft settlement or uplift at an intermediate stage of construction.

Temporary Shafts

(a) Full details of temporary shafts required by the Contractor's shafts working methods shall be submitted to the Engineers incharge for his agreement. Such shafts shall be adequately sized for all operations required for the execution of the works.

(b) Backfill for temporary working shafts shall comprise material agreed by the Engineers in charge.

(c) Where the Contractor wishes to recover temporary shaft linings the structure shall be removed in safe stages as backfilling proceeds, taking care to maintain the safety and structural integrity of the remaining lining. No part of temporary works shall be left in the ground within 2 m of the designed final surface level.

Shafts - Construction

(a) Shaft sinking shall be carried out by a method suitable for all the particular circumstances of the site including ground parameters, groundwater, depth and final purpose.

(b) Where work is done by underpinning, only that ground which may be safely excavated for the installation of one ring or one unit of support shall be carried out. Until that depth is properly secured by permanent or temporary shaft lining, no further excavation shall take place. In the case of pre-formed rings securing shall include grouting.

(c) Where work is done by a caisson operation, a cutting edge shall be fitted to the leading ring. The cutting edge shall be maintained at an even level all round during shaft sinking. Jacking arrangements or kentledge shall be adequate for the work. The Contractor's arrangements shall ensure the stability of any kentledge. A lubrication space shall be maintained around the full shaft periphery during sinking.

(d) Concrete walls installed by slurry trench or secant piling techniques shall comply with best
practice. The Contractor's proposals shall be submitted to the S.O. for his

agreement.

(e) Where low pressure compressed air is used to assist shaft construction, air decks and locks shall be designed by the Contractor to give adequate margins of safety against the air pressures to be used in the shaft. The Contractor's proposals shall be submitted to the Engineers in charge for his agreement.

(f) Full details of temporary works required by the Contractor's method of working for the construction of tunnel or pipe jack eyes in the shaft lining, shall be submitted to the Engineers in charge for his agreement.

(i) Shaft bases shall be concreted. The Contractor shall submit his proposals for the shaft base structure taking account of ground and groundwater forces and sealing the shaft against water entry.

11.6 Mild Steel Pipe Work (Jacking Pipe)

Spiral welded pipes manufactured from HR coils conforming to IS

10748 Grade 3 steel. Plate welded pipes manufactured from plates

conforming to IS 2062 Grade B steel.

I. Manufacture of Pipes

- **General**

Steel pipe shall be either plate welded or spiral welded pipe.

The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter with fixed outer diameter shall not deviate from theoretical one by more than 2 mm.

Any pipe or part thereof which develops injurious defects in the opinion of Engineer shall be rejected and shall be replaced by new pipe at Contractor's expense.

II. Plate Welded Pipes

All pipes and specials shall be manufactured out of mild steel plates conforming to IS 2062 Grade B steel. The procedure of cutting plates to size, rolling of plates, post bending, tack welding, internal and external welding, facing should be such that it results in pipes of required diameter and thickness conforming to IS 3589, or equivalent or better international standards.

III. Spiral Welded Pipes

All spiral welded pipes shall be manufactured as per IS 5504. The requirements for weldable hot-rolled carbon steel strip in coils should conform to IS 10748 Grade 3. The process of manufacture should be such that it results in pipes conforming to IS 3589/IS 5504 or equivalent international standards.

Demonstration

Contractor shall make necessary arrangements to demonstrate at the pipe manufacturing mill individual items of work before commencement of

works and during the works at intervals specified and as directed by the Engineer. No payment shall be made in this regard.

The works under demonstration shall include

(i) Manufacture of pipe and specials
(ii) Chemical and mechanical testing of pipes and specials
(iii) Machine and manual welding to qualify 'Welding Procedures'
(iv) External coating
(v) Cement mortar lining
(vi) Hydraulic testing after cement mortar lining at 12 bar pressure

Tolerances

Tolerances for pipes shall be in accordance with IS: 3589 except for the following.

Negative tolerance on pipe wall thickness is not permissible.

The permissible tolerances for specials for diameter, arm length and angular deviation shall be in

accordance with IS 7322/BS 534

Welding

Upon receipt of the order and prior to the start of works, the Contractor shall submit to the Engineer for his approval the 'Welding Procedure Method Statement' he intends to use for the field welding.

All components of pipe shell; either straight or bent etc. shall be welded by use of automatic arc welding machine by submerged arc process with alternating current. The strength of the joint shall be at least equal to that of the parent material. Manual welding shall be adopted only when machine welding is not possible.

The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. Standard current and arc voltage required for the machine shall be used with necessary modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer for qualifying the Welding Procedure Method Statement. Only approved welding procedures shall be used throughout the work and if any modifications are to be made, the written permission of the Engineer shall be obtained.

All the shop and field welding shall conform to IS 4353, IS 9595 and IS 816.

All longitudinal / spiral and circumferential joints shall be Single-V or Double-V butt joints with or without backing plates. After completing the welding joints of pipes or plates from one side, and before the welding on the other side, the joints shall be back chipped/ gouged and ground to remove irregular penetration till the even surface is exposed. Gouging shall be resorted to when the plate thickness is above 6 mm.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surface of plates match to provide stream lined joints without alteration in the internal diameter.

The welding shall be of the best workmanship free from weld defects. In order to maintain a good standard in welding, welders shall be tested by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operators shall conform to IS: 7307 and IS: 7310 (latest). Only those who pass the test shall be allowed to work on the job. Periodical tests as regards their competence shall also be taken at suitable intervals and those found incompetent shall be removed from the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be rectified to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory and qualified. Site welds shall be done by welders qualified for the various welding positions as per applicable IS codes and standards.

A record shall be maintained showing the names of welders and operators who have worked in each individual joint. Manual arc welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorised person shall be permitted to do any welding whatsoever.

The weldment should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment shall match with the base metal properties including original ductility. The weld should in no point be less than the nominal thickness of plate. A slight reinforcement as per IS codes shall be maintained on all weld joints. Final welding of closure gaps should be carried out within a temperature range of average air temperature 8° C.

- **Radiograph of welded joints**

Soon after welding, each longitudinal / spiral and circumferential welded length, the minimum length of the weld at random for each pipe shall be radiographed to detect welding defects, as per the requirements of IS 4853 and as directed by Engineer. This sampling will be at random to ensure 100% coverage of junctions of longitudinal / spiral and circumferential joints. If the results of such radiography fail to conform to the requirements, the Contractor shall carry out at his expense 100 % radiography test for the pertinent pipe as directed and fully satisfying the Engineer.

The percentage breakdown of radiography is as follows:

Pipes and Specials manufactured at Mill / Factory - 10%

Field joints welded at site - 5%

The weld ripples or weld surface irregularities and slag etc., on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The radiographs are to be marked in such a way that the corresponding portion of the welded seam and the welder can be readily identified. All radiographs will be reviewed by the Engineer to identify the defects and determine those which requires rectification. Defects that are not acceptable shall be removed by chipping, grinding or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by relevant Indian Standard specification.

All X-rays shall be taken with equipment and by personnel of the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor. A complete set of radiographs and records as described in IS: 2595, for each job shall be retained by the Contractor. All films shall be identified by the number and chart prepared indicating location of any work associated with the pipe erection and such inspection shall be performed by the Radiographer at the discretion of the Engineer.

Hydraulic Pressure Test at Pipe Manufacturing Mill

A hydraulic test shall be carried out at the mill for each pipe length fabricated. All pipes and specials shall be subjected to hydraulic test after fabrication, but before application of protective coatings and linings.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as slag, porosity etc. shall be repaired by gouging and re-welding.

Each pipe shall be filled with water slowly and the pressure increased uniformly until the required test pressure is reached. The test pressure shall be as follows:

MS pipes and fittings – 12 bars.

The pipe to be tested shall be given a serial number which shall be painted with details such as pipe number, shell thickness, diameter, length etc. It shall be entered in the register to be maintained by the Contractor. The register shall be maintained in suitable format giving the following information for each shell tested:

a) Serial No.
b) Pipe No.
c) Date of test

d) Specification, diameter and wall thickness
e) Weight of pipe shell tested
f) Maximum test pressure
g) Details of test performance
h) Name of Engineer's representative witnessing tests

A copy of these details shall be furnished to the Engineer

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding done after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected. The Engineer shall be supplied with two copies of the results of all the tests carried out.

No pipe shall be transported from the mill to the site and laid unless they have been hydraulically tested.

Tests and Inspection

The Contractor should submit results of inspection and testing covering the following in a suitable proforma, at the time of delivery of pipes in accordance with IS 3589/IS 5504. In case of discrepancy_between the requirements of the above standards the more stringent conditions shall apply. Each pipe shall be subjected to mechanical and hydraulic tests as per IS 3589 and the corresponding test certificates shall be furnished along with. The test specimen shall exhibit mechanical and chemical properties not lower than those specified for IS 2062 Grade B/IS 10748 Grade 3 steel. The tests should also include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894 on a test specimen provided from each lot of 100 lengths of pipe. Guided bend tests shall be carried out in accordance with IS 3589/IS 3600. One bend test shall be carried out from each lot of 50 lengths. The tests shall comply with the requirements specified in IS 3589/IS 3600.

The Contractor shall submit the following:

- pipe manufacturing process
- grade of pipe
- chemical composition – product analysis

- jointers

- tensile test report

- flattening test report
- weld test reports

- hydrostatic test report

- bend test report

- radiography report

- weld test report

The Contractor should notify the Engineer, in advance of the procurement of materials and fabrication in order that the Employer may arrange for mill and shop inspection (including third party inspection). The cost of tests including third party inspection shall be at Contractor's expense. The Engineer in his opinion may reject any or all materials or work that does not meet with any of the requirements of this specification. The Contractor shall rectify or replace such rejected material/performed work at his own cost to the satisfaction of the Engineer. The Engineer has the right to have the material tested independently to confirm the quality of the works.

The Contractor shall supply free of cost required specimen of materials for testing by the Engineer at any time during the progress of work and shall bear the cost of such tests or retests to the satisfaction of Engineer.

No separate payment will be made for any of the inspection and tests mentioned above and the rates for the items concerned shall be deemed to have been included in Contractor's item rates.

Mechanical Tests

The test plates shall be subjected to all mechanical tests as per the approved Method Statement, or as otherwise reasonably directed by the Engineer. Tests shall be carried out in accordance with relevant standards. The tests shall include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894. One test plate shall be provided for from each lot of 100 lengths

If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen submitted. The welded joint shall exhibit mechanical and chemical properties not lower than those specified for IS 2062 Grade B.

Guided Bend test shall be in accordance with IS 3589 /IS 3600. One bend test shall be carried out from each lot of 50 lengths. The test shall comply with the requirements specified in IS 3589/IS 3600.

The field welded joints shall be tested in accordance with the procedure laid down in IS 3600. One test plate shall be taken for every 10 joints and shall be subjected to mechanical and chemical tests as specified above.

Re-tests

If the results of tests of any lot do not conform to the requirements specified, retests of two additional specimens from the same lot shall be made, each of which shall conform to the required specifications. In case of a failure of one or both, gouging and repairing shall be carried out to the particular lot of joints from which the samples have been taken as directed by the Engineer before the lot can be accepted. The rectification process also shall have adequate test plates and they shall be tested for compliance with the IS codes/standards.

In case both the samples yield satisfactory results in the re-test described above, gouging and repairing will be required to be carried out on the joint which has failed in the initial test only.

All charges in connection with re-testing of the welded samples including machining, testing etc. shall be borne by the Contractor.

Marking

All pipes and specials shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates with suitable paints.

The following information shall be clearly mentioned on each pipe and special.

Manufacturer’s name with his registered trademark

Pipe / special with its serial number

Process of manufacturer and type of steel

Outside diameter (mm)

Pipe wall thickness (mm)

Length of pipe / angle of bend (in degrees)

Date of manufacture of pipe and special

Test pressure

After the hydraulic tests on the specials the direction of flow shall be stamped in a prominent manner. **Transportation, Handling, Stacking and Inspection**

- **General**

All pipes and specials manufactured at the mill shall be transported to the site of laying after cleaning them internally, etc. Vehicles on which pipes are transported shall have a body of such length that the pipes do not overhang. Pipes should be secure during transit. To ensure that laying of pipes is not

held up at any time, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, machine holes covers and short length of smaller diameter pipelines at site in his field stores in consultation with the Engineer. Whenever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked suitably along the alignment. All gaskets, nuts and bolts flange adaptors and other similar items shall be stored in dry conditions, raised off the ground in sheds or covered areas. Until required for incorporation each rubber ring or gasket shall be stored away from windows, electrical equipment and other materials like oil and chemicals and also from heat and cold. Where items require special storage requirements, the method of storage shall be to the approval of Engineer and in accordance with manufacturer's requirements. Storage areas shall be set out to facilitate unloading, loading and checking of materials. End covers and other protection shall not be removed until incorporation of the pipes or fittings into the Works. The Contractor shall provide 2 (two) sets of accurate 'Go" and 'No Go' ring gauges to measure the diameter of pipes, specials and fitting for the use of the Engineer at no extra cost.

- **Transportation and Handling**

The pipes and specials shall be handled in such a manner as not to distort their circularity or cause damage to their surface. Contractor shall provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of laying. The props shall be retained until the pipes are laid. Details of proposed propping (strutting) system shall be submitted to Engineer for approval and if required by the Engineer, the method of propping (strutting) shall be demonstrated and tested at site. Valves shall not be lifted by the spindle

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective/damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

- **Stacking and Inspection**

The Contractor shall keep a responsible representative to take delivery of pipes, specials and appurtenances, etc., transported from the pipe manufacturing factory or a stock yard. Pipes and appurtenances should be handled, stored and stacked in a suitable manner as directed by Engineer. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Gaps must be left between stacked pipes to permit access from one side to the other. The pipes, specials and appurtenances received at site shall be inspected and defects such as protrusions, grooves, dents, notches, damage to the protected coating, etc., shall be pointed out to the Engineer at site and in acknowledgement challans. Such defects shall be rectified or repaired by the Contractor at his expense, to the satisfaction of the Engineer. It will be the responsibility of the

Contractor to protect the pipes, specials and other items stacked along the alignment against any possible damages or theft.

External Coating

Unless otherwise specified or stated on the drawings the pipeline of diameter more than 1000 mm to be laid underground and the exposed pipeline supported on saddles shall be cement mortar coated

- **External Guniting**

Cement mortar coating shall be in accordance with IS 1916.

(i) Cement shall be Portland Cement in accordance with IS 8112
(ii) The cement content shall be 600 kg/m^3 and water : cement ratio by mass shall not exceed 0.3:1
(iii) A length of 15 cm at each end of the pipe shall be left ungunited to facilitate site welding. The end faces shall be vertical.

- **Mix Proportion**

Cement mortar shall consist of 3 parts sand to 1 part cement by volume. The water in the mixture shall be carefully controlled so as to attain the required strength and so that the mortar will not run, sag or segregate.

- **Thickness of coating**

The minimum thickness of the coating shall be 25 mm with a positive tolerance of 3 mm and no negative tolerance. Checking of the coating thickness shall be by non-destructive means such as ultrasonic thickness gauge.

- **Surface Preparation**

The surface of all pipes to be coated with cement mortar shall be thoroughly cleaned by hand or by sand steel grit blasting if necessary. After cleaning the external surface of pipe shall be given a coat of cement wash.

All oil and greases on the surface of the metal shall be removed thoroughly by flushing and wiping using suitable solvents and clean rags. The use of dirty or oily rags will not be permitted. All other foreign materials shall be moved by buffing or by scrapping and wire brushing. After cleaning, the pipe shall be protected and maintained free of all oil, grease and dirt that might fall upon from whatever source until the pipe has received its cement mortar coating.

If blasting is necessary, all metal surfaces shall be thoroughly blasted to bright metal. Blasted surface which acquire a coat of rust shall be cleaned/reblasted as directed by the Engineer

- **Reinforcement**

Reinforcement for the coating shall comprise of 50 x 50 x 3 mm wire mesh conforming to IS 1566 and 8 mm dia. bar to IS 1786. The mesh sheets shall

overlap each other by a minimum of 100 mm and be tied with mild steel wire at 200 mm intervals. The reinforcement shall be held off the pipe wall by a series of 10 numbers equally spaced 8 mm dia reinforcement bars which shall run the full length of the coating. Clear cover to the reinforcement shall be in accordance with IS 1916.

- **Application**

The pressure in the lower chamber of 'Cement Gun' shall be sufficient to produce a nozzle velocity of 115 to 150 m/sec when a tip with 19 mm opening is used. The compressor used shall be of an adequate capacity to maintain a pressure of at least 2.8 kg/cm^2 at the gun end. The nozzle shall be held at such a distance (65 to 100 cm) and position so that the stratum of flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits of loose sand shall be removed prior to placing any layer of gunite. Gunite shall be shot in one coat to the specified thickness. Every precaution shall be taken to prevent the formation of sand pockets and if any develop, they shall be cut out and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such a manner that no sloughing shall occur at any time during or following its application.

Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. When completed, the coating shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel towelled to a true surface equal in smoothness to the spun lining in such a manner not to impair the bond between mortar and steel plate. The guniting and surface finishing shall complete in set and shall be applied continuously without the use of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

If for any reason it is necessary to interrupt the placing of the gunite for a length of time that will result in the material taking a permanent set, a square shoulder shall be formed at the ends of the sections and/or elsewhere by shooting against a back or by working with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface face perpendicular to the pipe that will provide a suitable connection or construction joint between such material and the material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the material remaining in place or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints, they shall be carefully cleaned and wetted to ensure a good bond between the fresh material and that previously applied.

The ungunited portion at the ends of the pipe lengths left for the purpose of field welding shall be coated with M15 concrete by hand after the field welding and hydraulic testing are completed.

- **Curing**

After the mortar has set, but not later than twelve (12) hours after application of the coating, curing shall be commenced. Coating shall be kept continuously moist and in the shade for at least 14 days.

- **Inspection**

Pipe coatings shall be inspected prior to transports, to laying site and broken, defective or otherwise unsatisfactory areas may be rejected at any time during construction. All defective areas shall be made good to the satisfaction of the Engineer. Coating cracks over 0.25 mm wide or over 500 mm long shall be made good.

- **Tests**

Compressive strength test of concrete shall be conducted on 150 mm cubes in accordance with IS 516. The number of tests shall be at least 4 cubes for each age and each water cement ratio for each days work. The concrete mix shall have a minimum characteristic compressive strength of 25 N/mm^2 at 28 days.

- **Fiber Reinforced Coal Tar Enamel Coating**

Unless otherwise specified or stated on the drawings the pipeline of diameter 1000 mm and less to be laid underground and the exposed pipeline supported on saddles shall be externally coated with Fiber Reinforced Coal Tar Enamel at pipe manufacturing mill.

CHAPTER -12

RESTORATION OF ROADS

12.1 Definitions

The words like Contract, Contractor, Engineer (synonymous with Engineer-in-charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

The following abbreviations shall have the meaning as set forth below:

MOSRTH : Ministry of Shipping, Road Transportation and Highways

IRC : Indian Roads Congress

IS : Indian Standard published by the Bureau of Indian "Standards

GSB : GRANULAR SUB BASE

WMM : WET MIX MACADAM

BM : BITUMINOUS MACADAM

BC : BITUMINOUS CONCRETE

CBR : California Bearing Ratio

AASHTO : American Association of State Highway and Transportation Officials

ASTM : American Society for Testing and Materials

BS : British Standard published by the British Standards Institution

12.2 Applicable Codes and Specifications

The following specifications, standards and codes are referred to in this part.

IS : 460 : Specification for Test sieves
(Parts 1 to 3)

IS : 1077 : Common burnt clay building bricks - Specification

IS : 1124 : Method of test for determination of water absorption, apparent specific gravity and porosity of Aggregates / stones

IS : 1195 : Specification for Bitumen Mastic for Flooring

IS : 1196 : Code of Practice for Laying Bitumen Mastic Flooring

IS : 1834 : Specification for Hot Applied Sealing Compounds for Joints in Concrete

IS : 2386 : Methods of test for aggregates for concrete (Parts 1 to 8)

IS : 2720 : Method of Test for Soils for determination of Liquid and plastic limit. (Part 5)

IS : 6241 : Method of test for determination of stripping value of road aggregates.

IRC : 16 : Specification for priming of Base Course with Bituminous Primers.

IRC : 17 : Tentative specification for Single Coat Bituminous Surface Dressing

IRC : 19 : Standard specifications and code of practice for water bound macadam

IRC : 29 : Specification for bituminous concrete (Asphaltic Concrete) for road pavement.

MOSRTH

Specifications : Ministry of Shipping, Road transportation and Highways Specifications for Road and Bridge works

SECTION-101: GENERAL

SECTION-301 : EARTHWORK

SECTION-401 : GRANULAR SUB BASE
SECTION-502 : WET MIX MACADAM
SECTION-504 : BITUMINOUS MACADAM
SECTION-509 : BITUMINOUS CONCRETE

12.3 Road Restoration configuration

On laying of water lines / sewer lines in the trenches, the roads shall be restored to it's original condition in layers as per Drawing (Refer Standard drawings Volume 4) over the back fill as per concerned sections of MOSRTH

Technical specification:

a). Backfill over the water lines / sewer lines to the desired level as per drawing and specification.

b). Approved soil compacted in layers as per drawing, using soil deposited at site from road cutting and excavation to achieve compaction level Table 300-2 and Section 301 of MOSRTH Technical specification.

c). Layer of sand / stone dust as per drawing to achieve 97% relative compaction of laboratory dry density to meet requirement of table 300-2 of MOSRTH specification.

d). Granular Sub base as per section 401 of MOSRTH specification.

e). Wet mix macadam (WMM) as per section 502 of MOSRTH specification.

f). Bituminous macadam (BM) as per section 504 of MOSRTH specification.

g). Bituminous concrete (BC) as per section 509 of MOSRTH specification.

12.4 Materials

12.4.1 General

All materials shall be obtained from local sources and shall conform to technical specifications and be subject to Engineer's approval prior to use.

12.4.2 Approved soil for Subgrade / Embankment

The materials used in embankments, subgrades and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

The Contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the backfill/restoration works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

It shall be ensured that the subgrade material when compacted to the density requirements as in **Table 5.1** (As per Table 300-2 of MOSRTH specification) shall yield the design CBR value of the subgrade.

Table 12.1: Compaction requirement for Subgrade (As per Table 300-2 of MOSRTH Specification)

Type of work/material	**Relative compaction as % of max lab dry density as per IS: 2720 (Part 8)**

Subgrade and earthen shoulders	Not less than 97
Embankment	Not less than 95

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

i) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.
iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

12.4.3 Granular Sub base

The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or

combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the

Engineer. The material shall be free from organic or other deleterious constituents and conform to grading-iii given in **Table 5.2: Gradation for coarse graded granular Sub base.**

(As per Table 400-2 of MOSRTH Specifications).

Table 12.2: Gradation for coarse graded granular Sub base. (As per TABLE 400– 2 of MOSRTH Specification)

IS Sieve	**Percent by weight passing the sieve**		
Designation	**Grading I**	**Grading II**	**Grading III**
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	<10	<10	<10

CBR Value (Minimum)	30	25	20

The CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions, which shall be taken as being the density relating to a uniform air, voids content of 5 per cent.

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

12.4.4 Coarse Aggregates

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in **Table 5.3** and **Table 5.4** hereunder, as applicable. Aggregate for bituminous wearing courses shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous material applied to the stone in all weather conditions and especially in wet conditions. Basalt, dolerites are good in this respect; granite, quartzites are comparatively poor.

Table – 12.3: Physical Requirements of Coarse Aggregate for Wet Mix Macadam (WMM)

S.No	Test	Requirements	Test Method
1	Los Angeles Abrasion Value* or	40 percent	IS:2386 (Part – IV)
	Aggregate Impact Value*	30 percent	IS:2386 (Part – IV) or IS:5640***
2	Flakiness Index**	15 percent (max)	IS:2386 (Part I)

(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS: 5640.

Table – 12.4: Physical Requirements of Aggregates for Bituminous macadam (BM)

S.No	Test	Requirements	Test Method
1.	Los Angeles Abrasion Or	40 percent	IS:2386 (Part –
	Aggregate Impact Value*	30 percent (max.)	IS:2386 (Part – IV)
2.	Flakiness Index **	35 percent	IS:2386 (Part I)

3.		Stripping Value	25 percent	IS:6241
4.		Water Absorption	2 percent	IS:2386 (Part-III)
5.		Soundness		
		Loss with Sodium Sulphate – 5 cycles	12 percent (max.)	IS:2386 (Part-V)
		Loss with Magnesium Sulphate – 5 cycles		

(*) Aggregate may satisfy requirements of either of two tests

(**) Requirement of flakiness index shall be enforced only in case of crushed broken stone

12.4.5 Murum/Kankar/Gravel

Murum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and murum delivered at site must pass in every direction through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75 micron sieve.

Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.

12.4.6 Sand / Stone Dust

The sand / Stone dust shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5. The Sand used shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used. The sand / Stone dust / fine aggregates shall conform to grading requirement in Table 5.5

Table 12.5 : Gradation requirement of Sand / Fine aggregates
(As per Table 1000-2 of MSORTH Specifications)

IS Sieve Size	**Per cent by Weight Passing the Sieve**		
	Zone I	**Zone II**	**Zone III**
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100

2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

12.4.7 Bituminous Materials

Bituminous materials shall conform to IS: 73, IS: 215, IS: 217 or IS: 454 as applicable and be of the grade specified.

Table 12.6: Physical requirements of coarse aggregates for Bituminous concrete (BC). (As per TABLE 500-17: MOSRTH specifications)

PROPERTY	TEST	SPECIFICATION
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve.
Particle shape	Flakiness and Elongation Index	Max 30% (Combined)2
Strength*	Los Angles Abrasion Value 3	Max 30%
	Aggregate Impact Value4	Max 24%
Polishing	Polished Stone Value5	Min 55
Durability	Soundness:6 Sodium Sulphate Magnesium Sulphate	 Max 12%
Water Absorption	Water absorption7	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate	Minimum retained coating
Water Sensitivity**	Retained Tensile Strength8	Min 80%

12.5 Earth work

12.5.1 Earthwork in Excavation

In general the excavation shall be in accordance to Specifications specified elsewhere.

Profiles of road excavation shall be laid at 50 m intervals or as specified in Drawings to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Engineer in writing. If excavation is done below the specified level or outside the section the Contractor shall

be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections as shown in the drawings or approved by Engineer.

12.5.2 Earthwork in Subgrade

The Subgrade shall be formed of approved soil excavated from road trenches and stacked separately.

Profiles of subgrade shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions.

Subgrade material shall be placed in successive horizontal layers of 200 mm depth extending
to the full width of the Subgrade / trench to allow compaction of the full specified section to 150 mm using mini rollers / tampers / plate vibrators till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Before placing the
next layer of 200 mm the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The next layer shall also be
compacted to 150 mm to the full width of the trench section till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content.

When boulders, broken stones and similar hard materials are mixed up with the embankment materials care shall be taken to see that they are distributed uniformly into the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding.

If the soil contains less than the optimum moisture, water shall be added to the loose layers of the subgrade to bring the moisture uniformly upto requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent. The moistured/dried loose layers shall be compacted with a vibratory roller / mini roller / plate vibrator/ tampers to achieve the desired compaction level of 95% of Proctor density.

12.6 Compaction with Sand / stone dust

In order to achieve better compaction and a compacted surface before laying the GSB layer, two layers of sand / stone dust shall be laid and compacted to 150 mm each.

12.7 Preparation of Granular Sub-base (GSB)

Spreading and Compacting: The granular sub base material of **grade-iii** as specified in **Table 5.2: Gradation for coarse graded granular Sub base** (As per Table-2 of Section 401 – MOSRTH Specifications) shall be spread on the prepared sub grade maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub base material consists of combination of materials mentioned in clause 401.21, mixing shall be done mechanically by the mix in- place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small – sized jobs. The equipment used for mix-in-place construction shall be rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.
Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS: 2720 (part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under

compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re – compacted.

12.8 Wet mix Macadam Course (WMM)

The GSB layer surface over which Wet mix Macadam (WMM) is to be laid shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. WMM. sub-base

course of specified thickness shall be provided. The course aggregate for this shall conform to requirements in **Table-5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)** (As per Table 400-11 of MOSRTH Specifications).

Table – 12.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM) (As per Table 400-11 of MOSRTH Specifications)

IS Sieve Designation	Percent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95 – 100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

12.8.1 Preparation of WMM layer

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade /sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used so as to achieve the specified slope and grade. The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks

during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable vibratory roller. The speed of the roller shall not exceed 5 km/h.

12.9 Primer coat

Primer: The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. Surface of low porosity; such as wet mix macadam. The primer shall be bitumen emulsion.

Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in **Table-5.8: Requirement of Viscosity and quantity of Liquid bituminous Primer** (As per Table 500-1 of MOSRTH Specifications).

Table-12.8: Requirement of Viscosity and quantity of Liquid bituminous Primer
(As per Table 500-1 of MOSRTH Specifications).

Type of surface	**Kinematic Viscosity of primer at 60° C (Centistokes)**	**Quantity of liquid Bituminous Material per 10 Sq.m. (kg)**
Low porosity	30-60	6 to 9
Medium porosity	70-140	9 to 12
High porosity	250-500	12 to 15

Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8. and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

Application of bituminous primer: The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. The bituminous primer shall be sprayed uniformly in accordance with Clause 501 of MOSRTH specifications. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified. Curing of primer and opening to traffic: A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to

evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible.

12.10 Tack coat

Over the primed surface, a tack coat should be applied in accordance with Clause 503 of MOSRTH Specifications.

The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clauses 501.8 and 902 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in **Table-12.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat** (As per Table 500-2 of MOSRTH Specifications).

Table-12.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat

(As per Table 500-2 of MOSRTH Specifications).

Type of Surface	Quantity of Liquid bituminous material in Kg per sq.m.area
i) Normal bituminous surfaces	0.20 to 0.25
ii) Dry and hungry bituminous surfaces	0.25 to 0.30
iii) Granular surfaces treated with primer	0.25 to 0.30
iv) Non bituminous surfaces	
Granular base (not primed)	0.35 to 0.40
Cement concrete pavement	0.30 to 0.35

S.No.	Type of Surface	Quantity of liquid bituminous material in kg per sq.m area
1	Normal bituminous surfaces	0.20 to 0.25
2	Dry bituminous surfaces	0.25 to 0.30
3	Granular surfaces treated with primer	0.25 to 0.30
4	Non bituminous surfaces	
	Granular base (not primed)	0.35 to 0.40
	Cement concrete pavement	0.30 to 0.35

The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C.

12.11 Bituminous Macadam

The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS:73.

Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in **Table-5.10: Composition of Bituminous macadam (BM)** (As per Table 500-4 of MOSRTH Specification) for the grading specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-4.

Table-12.10: Composition of Bituminous macadam (BM) (As per Table 500-4 of MOSRTH Specification)

Mix designation	**Grading 1**	**Grading 2**
Nominal aggregate size	**40 mm**	**19 mm**
Layer thickness	**80-100 mm**	**50-75 mm**
IS Sieve (mm)	**Cumulative % by weight of total aggregate passing**	
45	100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight of total	3.1-3.4	3.3-3.5
Bitumen Grade	35 to 90	35 to 90

12.11.1 Preparation of the Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501.8 and 902.3 as appropriate, or as directed by the Engineer.

12.11.2 Preparation and transportation of the Mixture

The provisions of Clauses 501.3 and 501.4 shall apply.

12.11.3 Spreading

The provisions of Clauses 501.5.3 shall apply.

12.11.4 Compaction

Compaction shall be carried out in accordance with the provisions of Clause 501.6 and 501.7. The details of mixing, laying and rolling temperature of BM mix is as indicated in **Table-5.11:Manufactring & rolling Temperature of BM mix** (As per Table 500-5 of MOSRTH Specifications)

Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in Clause 903.

Table-12.11: Manufactring & Rolling Temperature of BM mix

(As per Table 500-5 of MOSRTH Specifications)

Bitumen Penetration	**Bitumen Mixing**	**Aggregate Mixing (º C)**	**Mixed Material (°C)**	**Rolling (º C)**	**Laying (º C)**
35	160 - 170	160-175	170 Maximum	100 Minimum	130 Minimum
65	150 - 165	150-170	165 Maximum	90 Minimum	125 Minimum
90	140 - 160	140- 165	155 Maximum	80 Minimum	115 Minimum

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

12.12 Bituminous Concrete

This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous macadam (BM) surface.

Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-18, for bituminous concrete.

The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-17.

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in **Table-12.12: Composition of Bituminous Concrete** (As per Table 500-18 of MOSRTH Specifications) and **Table-5.13: Requirement of Bituminous Concrete** (As per Table 50019: of MOSRTH Specifications).

Table-12.12: Composition of Bituminous Concrete
(As per Table 500-18 of MOSRTH Specifications).

Grading	**1**	**2**
Nominal aggregate size	**13 mm**	**10 mm**
Layer Thickness	**35-40 mm**	**25-30 mm**
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	
45		
37.5		
26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-37	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix[2]	5.0-6.0	5.0-7.0
Bitumen grade (pen)	65	65

Notes: 1.The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

2. Determined by the Marshall method.
3. Job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-19.

Table-12.13: Requirement of Bituminous Concrete

(As per Table 500-19: of MOSRTH Specifications)

Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	See Table 500-12 below
Per cent voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in water at 60ºC (ASTM D 1075)	Min. 75 per cent retained strength

12.12.1 Rolling

Immediately after the spreading of mix it shall be thoroughly compacted by rolling with vibratory rollers moving at a speed not more than 5 km per hour. Rolling shall be continued till the mix is thoroughly compacted to meet the general provisions of clauses 501.6 and 501.7.

12.12.2 Opening to Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer's Representative.

12.13 Quality Control of Road restoration works

12.13.1 General

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Engineer.

12.13.2 Tests on Earthwork for Embankment and Subgrade Construction

(i) Sand content [IS:2720(Part IV)]
1-2 tests per 8000 cu. metres of soil

(ii) Plasticity Test [IS:2720(Part V)]
Each type to be tested , 1-2 tests per 8000 cu. metres of soil.

(iii) Density Test [[IS:2720(Part VII)].
Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil.

(iv) Deleterious Content Test [IS:2720(PartXXVII)]

As and when required by the Engineer.

(v) Moisture Content Test [IS:2720(Part II)]
One test for every 250 cubic metres of soil.

(vi) CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [[IS:2720(part XVI)]

One test for every 3000 m^3 at least or closer as and when required by the Engineer.

12.13.3 Compaction control

Control shall be exercised by taking at least one measurement of density for each 500 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a days work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Tests locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in subgrade and in top 500 mm portion of the embankment below the subgrade, at least one density measurement shall be taken for every 100 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

12.13.4 Tests on Granular Sub base(GSB) and Wet mix macadam (WMM) layers

The tests and their frequencies for the different types of bases and sub-base shall be as given in **Table 12.14**. The evaluation of density results for compaction control shall be on lines similar to those set out in clause 5.10.1.

Table –12.14: Control Tests and their frequencies for Granular Sub base(GSB) and Wet mix macadam (WMM) layers

Sl.N	Types of	Test	Frequency
1.	Granular sub-base	i) Gradation ii) Atterbergs limit iii) Moisture content prior to compaction iv) Density of compacted layer v) Deleterious constituents	One test per 200 m3 One test per 200 m3 One test per 250 m2 One test per
2.	Lime/Cement Stabilised	i) Purity of lime (forlime-soil stabilization ii) Lime/Cement content iii) Degree of pulverisation iv) CBR test on a set of 3 specimens v) Moisture content prior to compaction vi) Density of compacted layer vii) Deleterious constituents	One test for each consignment subject to a minimum of one test per 5 tonnes of lime. Regularly, through procedural checks. Periodically as considered necessary. As required
3	Wet mix Macadam	i) Aggregate Impact Value ii) Grading iii) Flakiness Index iv) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 200m^3 of aggregate One test per 100 m^3 of aggregate One test per 200 m^3 of aggregate One test per 100

S.No.	Types of Construction	Test	Frequency
1	Granular sub-base	1) Gradation	One test per 200 m^3
		2) Atterbergs limit	

		3) Moisture content prior to compaction	One test per 200 m^3
		4) Density of compacted layer	One test per 250 m^2
		5) Deleterious constituents	One test per 500 m^2
		6) C.B.R	As required
2	Lime/Cement Stabilised	1) Purity of lime (for lime-soil stabilization)	One test for each consignment subject to a minimum of one test per 5 tonnes of lime. Regularly, through procedural checks. Periodically as considered necessary. A s required
		2) Lime/Cement content	
		3) Degree of pulverisation	
		4) CBR test on a set of 3 specimens	
		5) Moisture content prior to compaction	
		6) Density of compacted layer	
		7) Deleterious constituents	One test per 250 m^3. One test per 500 m^2 as required
3	Wet Mix Macadam	1) Aggregate Impact Value	One test per 200 m^3 of aggregate
		2) Grading	One test per 100 m^3 of aggregate
		3) Flakiness Index	One test per 200 m^3 of aggregate
		4) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 100 m^3 of aggregate

12.13.5 Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given in **Table- 12.15** hereunder.

Table – 12.15: Control Tests and their Frequency for Bituminous Works

S.No.	Types of Construction	Test	Frequency
1	Prime Coat/ Tack Coat	1) Quality of binder	As Required
		2) Binder temperature for an application	At regular close intervals
		3) Rate of spread of binder	Two tests per day

S.No.	Types of Construction	Test	Frequency
2	Bituminous macadam (BM)/ Bituminous Concrete (BC)	1) Quality of binder	As required
		2) Aggregate impact value, flakiness index and stripping value of aggregates	One test per 50-100 m^3 of aggregate
		3) Mix-grading	One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a maximum of two sets per plant per day.
		4) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close interval
		5) Stability of mix (vide ASTM: D-1559)	For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value, density and void content subject to a minimum of two sets being tested per plant per day.
		6) Binder content and gradation in the mix (Binder content test	One test for each 100 tonnes of mix subject to a

S.No.	Types of Construction	Test	Frequency
		vide ASTM:D-2172)	minimum of two tests per day per plant.
		7) Rate of spread of mixed material	Regular control through checks on the weight of mixed material and layer thickness.
		8) Density o compacted layer	One test per 250 m^2 area

CHAPTER-13

ACCEPTANCE TESTS

13.1 CHECK FOR OBSTRUCTION

a. As soon as a stretch of pipes whether of stoneware or cast iron or RC Pipes has been laid Complete from machine holes to machine holes, the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

b. If as a result of the removal of any obstruction the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory the Contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

c. It shall also be ascertained by the Contractors that each stretch from machine holes to machine holes is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line.

13.2 HYDRAULIC TESTING OF SEWERS

Immediately after the test with the double disc or cylinder as mentioned above has been completed and any defects thereby disclosed have been made good, the Contractor shall prove the joints of the stretch of under-ground pipes whether of stoneware, cast iron or RC Pipes, to be water tight.

Each section of sewer shall be tested for water tightness preferably between machine hole. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible In the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

In case of lowered stoneware pipes with cement mortar joints, pipes shall be tested three days after the cement mortar joints have been made. If it is necessary that the pipelines are filled with water for 7 days before commissioning the application of pressure to allow for the absorption by pipe wall. Where there is obstruction to traffic the period of 7 days allowed for absorption by pipe wall can be reduced by the engineer at his decision.

The Sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through tile air outlet, the stop cock is closed and water level in the funnel is raised to 1.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required is measured at an interval of 10 minutes to restore the original water level in the funnel. The pipe line under pressure is then inspected while tile funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on tile pipe surface is permitted), any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again. The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 litres/mm dia, of pipes per kilometre length per day.

Water and other accessories required for testing shall be to the account of the contractor.

13.3 AIR TESTING OF SEWER

The air test is to be conducted for sewers before back filling. It should not be used for testing after back filling or if the trench is water logged as under those conditions it is possible for a faulty line to be satisfactory.

The requirements of the codes of practice for the air test are that the length of pipe under test should be effectively plugged and air pumped in by suitable means until a pressure of 100 mm of water is indicated in a glass U-tube connected to the system. The air pressure should then not fall to less than 75 mm I during a period of 5 minutes without further pumping, after allowing a suitable time for stabilization of the air temperature. In case the drop is more than 25 mm the leaking joints shall be traced and suitably treated to ensure water tightness. The exact point of leakage can be detected by applying soap solution to all the joints in the line and looking for air bubbles.

13.4 TESTING OF MACHINE HOLE

The entire height of the machine holes shall be tested for water tightness by closing both the incoming and outgoing ends of the sewer and filling the machine holes with water. A drop in water level not more than 50 mm per 24

hours shall be permitted. In case of high sub-soil water, it should be ensured that there is no leakage of ground water into the machine holes by observing the machine holes for 24 hours after emptying it.

Water and other accessories required for testing shall be arranged by the contractor at his own cost.

Detailed Technical specifications of 28Ton Vehicle Mounted Suction and Jetting Unit with Water Recycling Facility		
Sr. No.	**Description**	**Technical Details**
1	**Vehicle Chassis**	
a)	GVW	28 T with maximum wheel base of 4600mm
b)	Engine Power Output	Min. 350 HP
c)	Emission Standard	BS- VI OBD II or the latest applicable
2	**Power Take Off**	
a)	Make	PZB-Italy/OMSI/OZCIHAN-MAKINA/ EQUIVALENT MAKE
b)	Max. Torque	Adequate to drive all the systems
3	**Tank**	

a)	Capacity of tank	10000 Liters
	i) Sludge -	9000 Liters
	ii) Freshwater -	1000 Liters
b)	Material of construction	Steel Plates
c)	Thickness	6 mm
4	**Suction System**	
a)	Make	JUROP/HIBBON/EQUIVALENT MAKE
b)	Capacity	Min. 6000 m^3/hr.
c)	Vacuum / Pressure rating	0.75 Bar Vacuum and 0.5 Bar Pressure
5	**Cassette Boom/ Derrick Arm**	
a)	Suction Hose Size	Ø 150 mm x 12 meters
b)	Type	Flexible rubber or PVC transparent hose
c)	Aluminum End pipe- 1 meter long – 1 No.	Ø 150 mm
6	**Filtration and Recycling System**	
a)	Type	multi-stage filtration system
b)	Hydraulically operated dewatering pump	Provided
c)	capacity	50 Microns
7	**High-Pressure Jetting pump**	
a)	Make	PRATISOLLI/URACA/EQUIVALENT MAKE
b)	Capacity	400 LPM
c)	Water Pressure rating	Min 200 bar; Max.300 bar
d)	Safety Valve	Provided
8	**Jetting Hose**	
a)	Type	Special water and grease-resistant flexible rubber material
b)	Size	1 ¼ inch
c)	Length	120 meters
9	**Hose Reel**	
a)	Material of construction	Alloy steel
b)	Capacity to stack for jetting hose	120 meters
10	**Operational condition capability**	Effective simultaneous combined operation of jetting and suction

b)	Capacity to stack for jetting hose	120 meters